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Queen's University
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Mineral Policy Formulation: The Role of Scientific and Technical Knowledge

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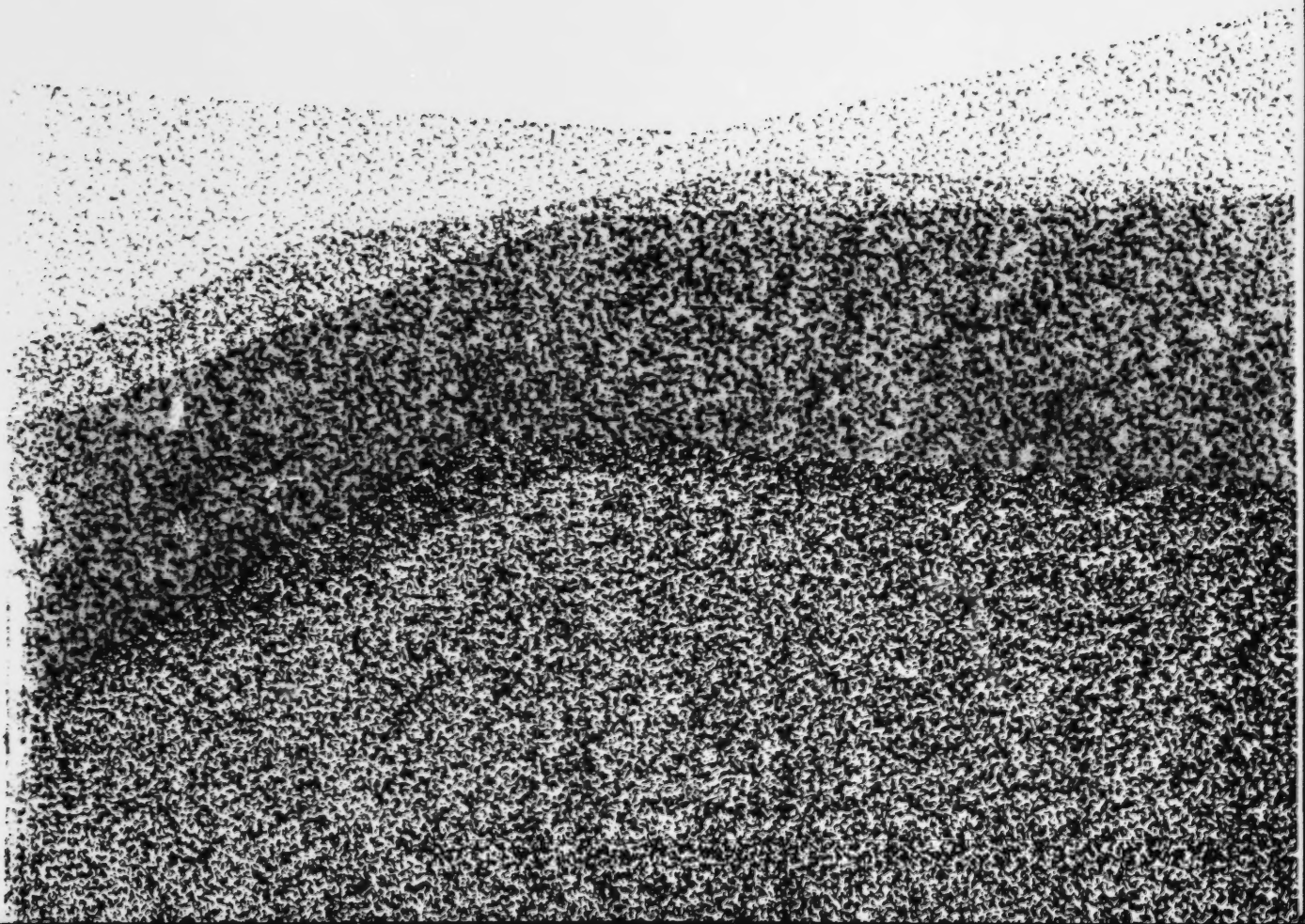

MINERAL POLICY FORMULATION:
THE ROLE OF SCIENTIFIC AND TECHNICAL KNOWLEDGE

Proceedings of the Tenth CRS Policy Discussion Seminar
Kingston, Ontario
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FOREWORD

This volume contains the proceedings of the tenth CRS Policy Discussion Seminar, jointly sponsored by the Carnegie Institution of Washington and the Centre for Resource Studies. The CRS seminar series brings together individuals from industry, governments, labour, universities and other organizations to exchange their knowledge, experience, and views on selected policy issues related to Canada's mineral resources. The subject of the role of scientific and technical knowledge in mineral policy formulation was selected at the request of the Carnegie Institution of Washington, which is undertaking a study to define and strengthen the appropriate links between earth sciences and mineral policy by drawing on the collective experience of the United States and Canada.

The seminar was held at the Donald Gordon Centre for Continuing Education in Kingston, on June 22-24, 1982. The program was organized by Brian Mackenzie and Andrew Freyman of CRS, in cooperation with Christopher Wright of the Carnegie Institution of Washington. The proceedings were edited by Margot Wojciechowski and produced by Marianne Leather.

The Centre is grateful for the papers prepared by the speakers, and for the active participation of the conferees in the workshops and discussions.

Views expressed are those of individual participants and do not necessarily represent the views of the Centre for Resource Studies or its sponsors, or of the Carnegie Institution of Washington.

Margot J. Wojciechowski
Centre for Resource Studies

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SUMMARY

Highlights of Presentations

G.A. Jewett

Policy analysis is a process of gathering data, selection of the significant elements, interpretation and analysis, and then communication of the results to the decision makers, who use it in their selection of policy options. The data provided must be accurate, timely, and relevant.

Those taking part in the process must be good communicators, with a good grasp of the data, an intuitive understanding of the subject, and an objective view of the options.

The process itself should ideally combine analysis and interpretation functions in fairly small groups, and keep all the groups interactive so there is more than one channel of access to the decision makers.

H.D. Drechsler

Public policy is an allocation of values in society. Policy analysis helps us proceed from where we are now to the objectives of the policy, i.e. to where we want to be. Policy analysis must include the intuition and judgement of the participants in the policy process, as well as their data and specialized knowledge.

Industry is often the supplier of data for analysis and interpretation. However, industry and government may end up at odds, if the mineral policy based on industry-supplied data conflicts with industry objectives.

P.G. Halkett

At one time, mineral policy decisions were made in mineral departments by persons with scientific and technical backgrounds. Since the 1970s, however, technically-trained people have increasingly lost their role in policy analysis, first to in-house generalists, and later to the staff of central agencies. If they wish to regain their influence, scientific and technical people should work hard at communications, at understanding the policy process, and at appreciating the broad range of objectives that must underlie all policies.

D.E. Bond

Establishment of policies and priorities is a complicated and sequential process, involving flows of requests and information horizontally between departments, and vertically through departments, central agencies and cabinet sub-committees to the cabinet. Smooth flow of requests is facilitated by seeking consensus at each stage, rather than confrontation. If scientific and technical experts seek consensus in the appropriate bodies and build up a reputation for accuracy and reliability, their assessments will be trusted and leaned upon heavily by Ministers at the decision-making stage.

D.C. Findlay

The two broad categories of regional mineral resource assessment are qualitative and quantitative assessment. These two are generally combined in varying degrees; an increasing qualitative component, however, means a decreasing level of certainty in the final results. Estimates generally involve a substantial element of qualitative input, while 'reserve' figures are highly quantitative.

The GSC has found that assessments that yield information about the relative potential (in terms of known resources) of land in present terms may prove to be the most useful in government policy decisions bearing on land use allocation. More quantitative assessments on the other hand will be essential for policies relating to supply of materials, provided that these speculative estimates are used with great caution.

W.G. Jeffery

Government involvement in mineral science and technology includes both basic science, such as the accumulation and analysis of geophysical data, and applied science, relating to the technology of exploration, mining, and mineral processing. Government research is more likely, for financial reasons, to be high-risk and long-term than is the research done by the corporate sector. Justification for government involvement in this area includes the need for: a broadly-available base of knowledge; costly scientific facilities; data for government policy analyses; health and safety and environmental protection; new technical options for industrial diversification and development.

L.G. Bonar

Industry and government need to work together in harmony to establish rational policies for the mineral industry. Industry has a responsibility to assist government in obtaining an accurate, comprehensive and up-to-date data base

for such policies. Furthermore, the expertise of those in mining includes not only geotechnical areas but also marketing, economics, international relations and taxation. Industry would like to participate in an open and continuous dialogue with government across a broad spectrum of national and international issues leading to mineral-policy-related decisions.

D.W. Davis

Mine development agreements with the private sector should be used in a rational way to develop specific aspects of mineral policy, and to preserve some policy stability. Such agreements should be negotiated individually only during a 'learning phase' for an untested resource or resource class, as part of the process of determining what is competitive and establishing a policy. Thereafter, relatively standard leasing agreements are in the best interest of any jurisdiction wishing to maintain a stable and positive investment climate. Unfortunately, scientists and engineers appear to have been effectively 'locked out' of this and other aspects of policy development in recent years, and policies may therefore suffer from a lack of technical input.

J. Zwartendyk

Poor linkage between technical and policy levels can lead to unintended but very misleading errors in the estimates of reserves or resources which are used in policy analysis and in the development of mineral policies. Scientists need to develop and/or use communication techniques which bypass some of the complexities of resource classification and terminology, and which therefore minimize the chances for such misinterpretations. Policy analysts for their part need to formulate their policy-related questions very carefully, in order to elicit valid and useful responses from the scientists.

Summary of Discussions

Participants agreed that mineral policy formulation requires data collection, interpretation and presentation for input into policy analysis. Analysis is followed by identification of policy options. The final policy is then selected from the available options. The whole process is generally triggered by the identification of problems or opportunities that are perceived to require some response by government. In Canada, scientists and engineers have played and continue to play a major role in providing raw and interpreted data for the policy process. Up to the 1960s, they also played a major role within resource departments in policy analysis and in identification of policy options. However, since the 1960s, their involvement at this level of the process has declined rapidly and has largely been assumed by economists and other social scientists both within resource departments and, increasingly, in central agencies.

Among the many reasons suggested for this change in Canadian mineral policy formulation, the most significant appeared to be the diversification of mineral policy objectives, which had broadened from promotion of the international competitive position of the Canadian mineral industry to include many (and sometimes conflicting) objectives in the social, political, environmental and economic fields.

Participants felt that mineral policies are now suffering from this loss of analytical input from scientists and engineers, and suggested a number of ways in which the trend might be reversed:

i increased use of mineral economists (i.e. geoscientists and engineers with additional interdisciplinary training) by government resource departments;

ii a conscious attempt on the part of geoscientists to improve their communications skills and to seek feedback, to ensure that their technical data inputs are understood and given proper weight by policy analysts;

iii a conscious attempt by geoscientists to acquire the political and consensus-seeking skills necessary to work within the system and participate in policy analysis and formulation;

iv a conscious attempt by bureaucrats to seek out the technical advice they need to formulate rational policies.

MINERAL POLICY FORMULATION:
THE ROLE OF SCIENTIFIC AND TECHNICAL KNOWLEDGE*

by

Brian W. Mackenzie

The Canadian Setting

In recent months, mineral issues have been the subject of increasing concern in Canada. The federal government's November 1981 budget paper, Economic Development for Canada in the 1980s, gives prominence to natural resources, including minerals, as the leading opportunity for national economic development. In March 1982, Energy, Mines and Resources Canada released Mineral Policy: a Discussion Paper. This policy document describes key factors and issues impinging on the mineral idustry, and establishes priority areas. At the same time, the Canadian mineral industry is in the midst of a deep and prolonged recession which as yet shows no prospect of abating. Mineral policy, at both federal and provincial levels, will have a crucial effect on the ability of the mineral industry to recover from present adversities and respond to the challenge of continuing its key role in Canadian economic development.

Mineral policy has received a considerable amount of attention in Canada during the past decade. Unfortunately, results have generally oscillated between broad 'motherhood' statements of progressive intentions on the one hand and the implementation of restricted, unconnected policy mechanisms on the other. A general but meaningful mineral policy framework between these two extremes has not yet been revealed.

Major investments of time, effort, and professional expertise in mineral information systems and analytical capabilities have been associated with these mineral policy initiatives. However, the linkages between information and analysis have often been weak, and their impact on mineral policy decisions has in general been obscure. In any case, mineral policy measures have all too often failed to provide lasting solutions.

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* A more extensive version of this note was distributed to the seminar participants as background material for discussion.

Seminar Terms of Reference

The purpose of this seminar is to examine the mineral policy and planning process as it currently exists in Canada, and to consider ways in which it may be strengthened. The focus is on the role of scientific and technical knowledge in the policy process. Usually, emphasis is placed on economic, strategic, and political consequences of mineral policy. Relatively little attention has been paid to the input of scientifically and technically trained professionals to the formulation of policy. However, if mineral policy decisions are to be realistic and of lasting value, they must be founded on a practical understanding of the technical aspects of the mineral industry and, particularly, of the special concerns which arise from working with a geological environment. Thus, the role of geologists, mining engineers, and metallurgists is basic to the multidisciplinary policy formulation process.

Technically trained and experienced personnel must assume their full share of responsibility for enhancing meaningful dialogue between government and the private sector, and across disciplines and policy functions, through to the decision-making level. To do this, they should be in a position to initiate suggestions for improvement as well as to respond to policy concerns.

The Canadian experience suggests that there is a lack of understanding

i by decision-makers of the need for policy analysis;
ii by policy analysts of decision-making requirements;
iii by policy analysts of the need for appropriate data;
iv by data collectors of policy analysis requirements.

The seminar has tried to work towards a better understanding of these requirements, and thereby help to strengthen the linkages between information, analysis, and decision-making functions. We feel that there is tremendous scope for increasing the efficiency of the mineral policy and planning process in terms of quality, relevance and effectiveness through this type of synthesis.

Mineral Policy Formulation

A process of information assembly and analysis is necessary to support mineral policy decisions. The specifics of this process vary in practice depending on such factors as the characteristics of the mineral industry, and public and political perceptions of government's role in shaping its development. However, certain basic components must be present if the support process is to respond efficiently to the needs of policy decision-making.

What are these basic components and how should they be integrated within an organization charged with mineral policy responsibilities?

A conceptual representation of the mineral policy and planning process is given in figure 1. The activities depicted are justified and conditioned by a variety of external demands which are made for mineral economics services within government. One of these demands is for the public disclosure of mineral sector information. Another type of demand is for future projections and forecasts of mineral industry performance. Most importantly, there are demands for the analysis of mineral policy issues to provide a basis for government decision-making.

These external demands emanate from a wide variety of sources: the public, the mineral industry, other government levels and jurisdictions, other departments within a government, inter-departmental committees, and other branches or divisions within a department. While all types of demands must be addressed, the prime responsibilities lie with the minister concerned, and the central economic planning offices and appropriate cabinet committees.

How does an organization develop the capability to satisfy these external demands? Figure 1 suggests the basic components that are required:

i a central information system;
ii on-going assessment of the value of the mineral sector;
iii analysis of mineral policy and planning issues.

Organizational resources must be balanced among these functions. Furthermore, they must be effectively linked through a system of internal demands and communications. More important and more difficult to achieve are the linkages between the organization and the decision-makers: the minister, central economic planners, and cabinet committees. Information and analysis, as implied in figure 1, should be organizationally separate from these decision-making authorities to promote unbiased data and objective analysis.[1] Yet, if these external lines of communication are not open, the information and analysis functions have no real purpose.

At the core of the mineral policy and planning process is a relevant inventory of technical and economic data concerning the mineral sector. It is the ability

1. An excellent examination of the role of information and analysis in the mineral policy process can be found in National Non-Fuel Minerals Policy Planning Process, report of the Committee on the Requirements for a National Materials Policy Planning Process, W.A. Vogley (chairman), National Materials Advisory Board, Publication NMAB-384, National Academy Press, Washington, 1981, 23pp.

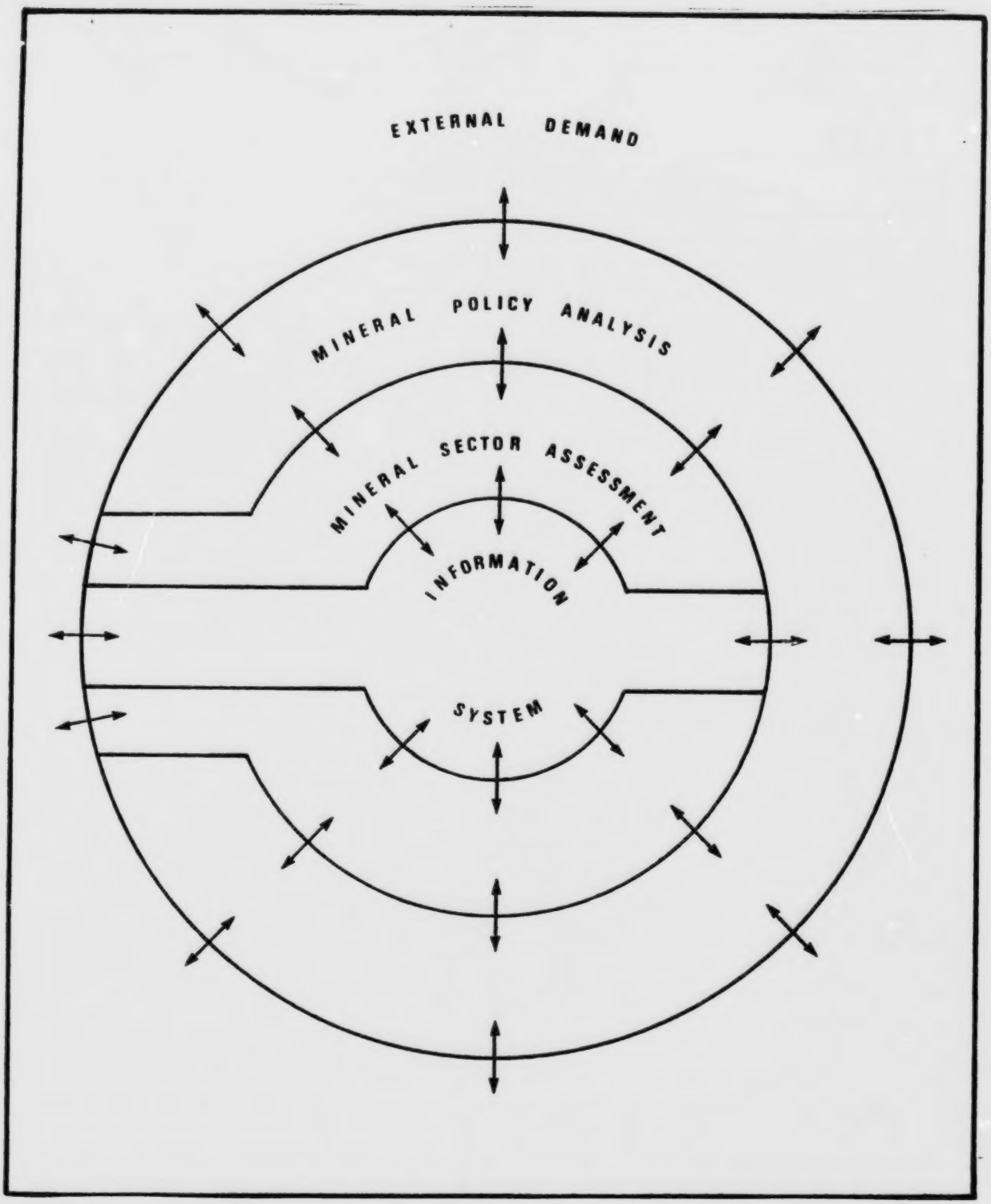

Figure 1. The mineral policy and planning process.

of this information pool to further the understanding of the past and to provide a basis for looking into the future that makes it valuable. Thus, the usefulness of the information system is determined by the analytical procedures within which it is marshalled and used to improve understanding. The information system should be controlled by a sound understanding of the economic and technical characteristics of the mineral sector.

One way or another, information flows into this core component from the mineral industry itself. This then represents one important interface between government and the private sector. It is important to recognize the impossibility of designing an information system that will fulfill all possible purposes. The focus should be on long-term mineral policy needs.

Because of the high degree of variability which characterizes the mineral industry, information will generally be required on a site-specific basis. A high level of technical expertise is required to assemble, verify, and realistically interpret this type of data.

While the information system is directly used to respond to external demands, its main purpose is to provide direct and indirect input for policy analysis. In particular, the information system underlies the middle-ring component of the policy and planning process: on-going assessment of the technical characteristics and economic value of the mineral industry.

The purpose of the middle ring of activity is to translate the basic information assembled into more readily usable assessments of the value of the mineral sector. It provides a necessary bridging mechanism between information and analysis, providing both a focus for data collection and a base for policy analysis.

The types of assessment carried out here might include:

i appraisal of unknown regional mineral resource potential;
ii assessment of the economic value of the mineral sector in terms of existing mining operations, known but presently undeveloped deposits, and exploration potential;
iii mineral market research including evaluation of the competitive position of the industry in international mineral markets.

Such assessments require the development of appropriate analytical procedures in addition to the continual updating and extension of data. Results are used to satisfy external demands for forecasts of mineral sector activities. More importantly, the development of this function provides a capability to evaluate

mineral policy alternatives more fully and to respond to mineral policy issues more quickly and systematically.

The outer ring of activity concerns the analysis of mineral policy issues, founded on the support provided by the inner two functions. The primary rationale of an organization charged with mineral policy responsibilities is to identify emerging policy issues, analyze these quickly and comprehensively, and communicate the results of the analysis to the appropriate decision-makers. It must be capable of initiating suggestions regarding appropriate policy measures as well as of responding to concerns of the decision-makers.

It is very costly and ineffective to approach each mineral policy issue on an ad hoc basis. The process outlined here is designed to provide a more efficient and sustainable capability. Integration and synthesis among the three basic components are critical to its success.

The Seminar Structure

The foregoing conceptual framework for mineral policy formulation helped to define topics for the invited seminar papers, and to structure and stimulate seminar discussion in key areas of interest.

The first four presentations considered the critical lines of communication between the organization responsible for mineral policy analysis and the political decision-makers. The last five papers were concerned with the linkages between information, assessment, and analysis within this organization and, in particular, the role of scientific and technical knowledge.

DIGEST OF DISCUSSIONS*

Mineral Policy

Following H.D. Drechsler's presentation, participants spent some time discussing the definition of the term 'policy'. The discussion initially centred around whether or not a policy is a societal goal or a means of achieving such goals.

Some participants agreed with Drechsler that a policy is a goal involving value judgments and involves modifying human behaviour in order to reach the goal. Societal goals can be either very simple, as in wartime when the goal is victory, or very complicated, incorporating a variety of political, social, and economic considerations and values. Where there are numerous goals, the means to achieve them can compete or even conflict, and lead to confusion or to policies that are counterproductive.

Proponents of the 'policy as means' view, on the other hand, felt that policy analysis involves looking at options, and selecting the alternative best suited to achieve some predetermined goal or set of goals. The option selected is then the policy. The example of the National Energy Policy (NEP) was cited, where the NEP is a collection of measures and legislation that make up the means to help achieve the goal of energy self-sufficiency for Canada.

The selection of the best option requires considerable insight and skill, and offers an important role for technically-trained people. This is in contrast to the setting of societal goals and values where, it was suggested, science and technology have no special role to play.

Some participants suggested that the concepts of societal goals and values had no place in a discussion of policy, because, they felt, these concepts are irrelevant to the ministers and senior bureaucrats who establish policies; the former are interested only in staying in power, and the latter in protecting their ministers. Consequently, the policy horizons are effectively limited to the time of the next election. Others, however, found this a harsh representation, and felt that, although political consideration may be overriding in times of crisis, ministers do give thoughtful and careful consideration to values and long-term goals.

* This digest is a synthesis of the views and opinions expressed by seminar participants, and has been prepared by the Centre for Resource Studies.

It was also suggested that events, such as unemployment or loss of markets rather than values, shape and determine policies. This view sees policy principally as a reaction to short-term conditions rather than as a pursuit of long-term goals.

It was noted by one participant that the disagreement over goals or means as policies arose in large measure from a failure to distinguish between long-term and short-term considerations. Over the long term, societal goals such as protection of international competitive position may determine policies. In the short term, however, policy measures definitely tend to be problem-solving, responding to events and changing situations. However, even short-term policies must recognize the long-term goals and realities, and distinguish between what can and cannot be dealt with by government action. Among the unalterable long-term realities mentioned were increasing competition from third world countries, and the fact that Canada is a price-taker in international mineral markets.

In the discussions that follow, 'policy' is generally used in the sense of a means to an end. Although scientists and engineers have no special role to play in establishing the goals of society, they do have special contributions to make in finding the means to accomplish these goals.

One participant pointed out a way in which public policy differs significantly from corporate policy. He spoke of goals and means as two dimensions of policy, and noted that in the private sector, which may share public sector goals such as growth, the means to achieve such goals tend to be determined exclusively by economic considerations. In the public sector, however, means as well as goals may have normative values attached, and may be designed to meet a variety of additional socio-economic objectives.

The principal long-term objective of Canadian mineral policy, it was generally agreed, should be the maintenance of Canada's international competitive position in mineral markets, in order to contribute to growth in the Canadian economy. Dr. Drechsler suggested that the mineral policies that have actually evolved within the context of these objectives have four major aspects:

i regulative (e.g. in the environmental or health and safety fields);
ii organizational (e.g. the structure of EMR);
iii distributive (e.g. the distribution of rents through fiscal policies);
iv extractive or developmental (e.g. influencing rates of exploitation).

Of these four, i and iii have most frequently sent out conflicting signals to the mineral industry, and been called counterproductive to the overall objectives.

Mineral Policy Formulation

The Players

Politicians, particularly ministers: it was suggested that politicians do not establish objectives for bureaucrats to meet; rather, they present problems and ask for solutions. In addition, according to one participant, unless a minister has been a bureaucrat himself, he doesn't want to be given options to consider.

Central agency staff: to a large extent, they have replaced the geologists and mining engineers, the in-house technical experts, of the departments responsible for the mining industry in the area of policy analysis and formulation. Extremely few central agency analysts have any technical training. They represent a new intrusion made necessary by the emergence of new objectives (e.g. social and economic) which have resulted in the downgrading of the importance of technical considerations within mineral policy.

Policy analysts within ministries: few at this level have technical training. Option papers prepared by policy analysts tend to have limited objectives related only to the mandate of their own ministry, and rarely take other objectives into account, it was suggested.

Geologists and engineers in ministries: this group's influence over mineral policy has declined noticeably over the last two decades. In addition to competing for influence with nontechnical analysts in their own ministries and in central agencies, the geologists and engineers compete among themselves for information, resources, priority for their work, and access to policy-makers.

Industry: it was suggested that corporate influence has also declined sharply in the mineral policy area since the 1960s. One industry participant noted that he tends to learn about mineral policy initiatives through the public media. The decline of industry influence was attributed to a number of factors, including the decline of economic growth as the preemptive goal of governments, and the diversity of interests among mining companies, which weakens their ability to act in unison when communicating with governments.

Other interests: other interests identified included labour, research organizations, and interest groups. The possibility was raised that central agency staff, who have gained influence over policy formulation at the expense of departmental technical experts, may in turn lose influence to public hearings dominated by special interests which are largely nongovernmental. The recent Nova Scotia uranium exploration moratorium was cited as an example of this sort of development, as was the Berger enquiry in the 1970s which led to a 10-year

moratorium on the Mackenzie Valley pipeline. This raised the concern that technical input may become further ignored as a consequence of the fact that some technical people attached to special interests, who gain credibility because of their qualifications, may have biases that lead them to use their knowledge in a subjective and misleading manner during the course of public hearings. This has been seen, for example, in antinuclear movements. At the present time, however, 'other interests' play a relatively minor role in mineral policy formulation in Canada.

Communication Networks

Participants noted that geologists and engineers must understand the communication network involved in policy formulation if they are to play a role in the process. In addition, the process itself must allow good communication from the data-gathering level up through analysis and selection of options through to final policy decisions. The communications must be two-way, permitting feedback to reach the data gatherers and analysts so they can assess and adjust the relevance and quality of their work. Ideally, there should be flexibility in information flows, with alternative channels available.

However, it was felt that communication problems exist at every level in government. The formalized structures found in governments, and in industry as well, inhibit flexibility in information flows. Problems of confidentiality may impose constraints as well. It was suggested that confidentiality, which is a barrier to information flows, is nevertheless essential in order to maintain trust between contacts, and to prevent premature alarm among some sectors when wide-ranging options are in the early or experimental stages of discussion.

Communication between governments and outside interests came in for criticism as well. It was noted that federal central agencies, for example, have very little contact with their provincial counterparts, although this is less true for the Department of Regional and Economic Expansion (DREE) than for other federal central agencies. Contacts between government and industry have deteriorated simultaneously with the rise of social and environmental concerns and other new government priorities. It was noted that Prime Minister Trudeau, unlike some of his predecessors up to the early 1960s, has virtually no close corporate ties. At the same time, interests of mining companies vary widely, according to their size, products, operations, markets and degree of integration. As a result it is increasingly difficult for the mining industry to present the common front required for successful input of technical data and other considerations from industry to the policy process. University and other research groups, with a few exceptions, tend to be very individualistic and therefore have a small and

relatively ineffective input, even though communication may be fairly easy and the quality of the data may be high. Labour groups probably have the least access to the system, and what little communication there is is hampered by a mutual lack of trust.

Among the examples of communication problems that were cited by participants are the conflicting signals received by industry concerning northern development. Over the last decade the federal government has spoken encouragingly of northern development, but recent government actions such as termination of the tax-free status of northern employee benefits discourage new developments and jeopardize existing ones. It was suggested that Canadian industry is somewhat naive in terms of interpreting such conflicting signals from governments, and should take more care to identify the sources of the signals and to assign weights to them. Conflicting signals are of more than academic interest to industry, since they may lead to development decisions that are later rendered uneconomic by changes in mineral policy or by new policies in other areas. Conflicting signals seem to be becoming more frequent, as new and sometimes incompatible priorities arise, encompassing the traditional goal of economic growth as well as newer concerns about equity, sovereignty, health and safety, environmental protection, north-south dialogue, etc. The problem has recently been particularly acute in the USA as well, it was reported, as the Ford, Carter and Reagan administrations changed policy directions dramatically over a relatively short span of time.

An industry representative pointed out that, in order to improve communication, there is a great need for harmony within government, between governments, and between government and industry. Accomplishment of such harmony is essential if Canada is to achieve rationality and effectiveness in its policy process and the resulting policies.

Process

Ideally, the policy process is triggered by problems or opportunities, and draws upon a foundation of data, largely collected by or for the government. The raw data are transformed into information which becomes input into analyses. The analyses are used to develop options, one or several of which may then be selected by the policy-formulators as policies. The last three stages of this process were described in some detail in David Bond's presentation, while the first two, data and information, were discussed by G.A. Jewett, D.C. Findlay, W.G. Jeffery and J. Zwartendyk.

Data and Information

Mineral industry data may include figures on resources and reserves, production, costs, prices, markets, and other related items. Incorporation of these technical ingredients into the policy process depends on the skill of the technical experts in anticipating information needs and in bridging interdisciplinary gaps. It was noted that the Japanese seem to be especially adept at this aspect of the policy process, and that oil and gas companies have had good success as well in assembling multidisciplinary teams that can transfer information through the corporate policy process.

Technical data related to the mineral industry, however, are only one part, and an increasingly small part, of the total information entering the process. Other inputs are related to other economic sectors, socio-economic considerations, environmental concerns, fiscal constraints, political realities, etc. As a result, even if the information introduced to the process by geotechnical experts reaches the policy level, it may be ignored because of competing considerations. Government participants stressed that this possibility demands great care from geologists and engineers in the selection and preparation of their data inputs, in order that the resulting information be given adequate weight during deliberations.

Furthermore, some decisions involve conflicting and irreconcilable objectives, and even the best possible presentation may not be successful. Several examples were cited of cases where seemingly irrefutable technical arguments in favour of programs to assist the mineral industry (for example, proposals promoted by the Prospectors and Developers Association, supported by EMR, but rejected by Finance) were overthrown by the ultimate argument, fiscal constraints. When policy decisions involve government revenues, petitioners cannot offer alternative sources of revenue; nor can they propose budget cuts. Consequently their petitions may receive minimal consideration and be rejected.

Analysis

Once introduced to the process as information, technical data enter into the policy analysis stage. This stage occurs within departments, in central agencies, and in interdepartmental groups. While the data are known, as one bureaucrat pointed out, the unknown factors in the analysis stage are the assumptions used to manipulate the data. Participants stressed the necessity for identifying these assumptions, as well as for separating information based on historical data (i.e. fact) from uncertain future projections in the analysis stage.

Some industry participants pointed out that the analysis process, with its many levels, stages, and committees, is too long and too wide-ranging, often failing to focus on the crucial questions. The NEP for example took two years to develop, and caused a slow-down in the energy field due to the industry's uncertainty over the final outcome.

Options

Analysis should conclude with the development of policy options which will resolve the perceived problems or take advantage of the opportunities, and the presentation of these options to the cabinet. It was suggested by some that politicians generally do not look for or even want options, and so it is essential that options be presented, with supporting arguments, as clearly, briefly, and objectively as possible. If the options are not realistic, they will be rejected by other bureaucrats who are supporting other options which may further other objectives. To avoid this, the analysis stage should include an assessment step that leads to some compromises and to consensus.

Public discussion of options was described as a real problem for the cabinet system of government, because although all options must be considered and evaluated by cabinet, public discussion may arouse concern that any or all may actually be adopted.

The current difficulties facing Cyprus Anvil Mining were cited as an example of an event which creates the need for careful evaluation of short-term options. Cyprus Anvil, which has been the major employer in the Yukon Territory, has closed its Faro operations. Should government get involved? If it should, should it help the mine and therefore the region? Or should it let the mine go, and help the region directly? All the options involve value judgments, but all must be firmly based on data and analysis.

Some participants complained that it appears that governments rarely consider the option of cutting costs when faced with revenue-expenditure imbalances. Although this option is routinely forced on companies, which have little control over prices and demand and therefore over revenues, usually governments seem to redress their own imbalances by increasing revenues.

Policy Selection

Once the options have been presented, final selection of policies occurs at the political level. Participants stressed the need for speed throughout the pro-

cess to keep the selection relevant, pointing out that if the whole process takes several years, policy decisions will be based on data that are more than several years old. Ideally, policies should be selected for their suitability for achieving long-term objectives, for providing stability through changing conditions and even governments. At the same time, they should have built-in flexibility, permitting short-term adaptations or course-corrections to keep them heading for the long-term goals.

It was noted that the U.S. Congress deals best with changes in existing policies (i.e. short-term adaptations) rather than with the introduction of new policies. While this may provide for stability, it does tend to reduce the opportunities for consideration of new options and objectives.

The selection of the best options requires a clear understanding of the political goals being pursued. In Canadian mineral policy, a major objective is maintenance of Canada's competitive position in international mineral markets. In the United States on the other hand, the goal is security of supply of minerals. These objectives must be borne in mind at all levels of the policy process, including the collection and presentation of scientific and technical data.

The Role of Scientists and Engineers

Data Collection

The papers by Zwartendyk and Findlay dealt with this function in considerable detail. As they explained, scientists and engineers collect geotechnical data that go into the policy formulation process, select what is relevant, interpret it, and present the resulting information to policy analysts in their own and other departments, and in central agencies. Participants felt that the nature of the information collected should be determined to a large extent by the priorities of the policy formulators, although much is collected because it is tradition, or is considered important by the technical people. In addition, information is prepared as a service to other clients in government and industry.

Technical data can be classified in many categories, including the following: basic geoscience; exploration; production and costs; marketing; and financial, including taxation. Each is collected for different purposes, by different agencies, and with varying degrees of confidentiality.

Basic geoscience data are largely collected by government geoscientists working in the field. Most are interpreted and made available to the public as soon as possible in the form of reports and maps. Exploration information on the other hand is usually collected by industry, and is proprietary in nature. The portion made available to governments as assessment reports and in other forms must be aggregated to protect the confidentiality of information from individual firms before it can appear in published reports. Basic geoscience and exploration data are combined to produce information on resource and reserve assessments.

Production and cost data collected by governments are based largely on reports submitted by industry and again aggregated for confidentiality reasons. Production forecasts, for example, are used in aggregate form to develop supply monitoring curves. Some additional information is obtained through research programs conducted by both the public and private sectors. Industrial research has tended to concentrate on ways of reducing the costs of production and on new products to expand markets (particularly in the case of nickel) while, as Dr. Jeffery pointed out, government research has been more fundamental or related to regional development, environmental, and health and safety considerations. This situation may be changing somewhat, as CANMET and other government agencies have turned increasingly to more applied areas of research.

George Bonar pointed out that marketing data are collected by a variety of agencies and that, unlike most other data inputs, mineral marketing data must be international in scope. Timeliness was cited by several speakers as a particular problem in this area, at least for short-term marketing purposes. It is less significant for long-term public policy decisions. Canadian government market data were criticized by some participants as not being sufficiently timely. They are published on a quarterly basis, while similar information is available from Japan with a lag of only 20 days.

Financial and taxation data are also assembled by industry and collected and aggregated by governments. Although geoscientists have little to do with the collection of financial data, financial and production data are combined to produce information on productivity, and all the above data types are needed for analysis of our international competitive position.

Data Interpretation and Presentation

Geologists and engineers are involved in the process of interpretation of mineral data for presentation as input information to the policy analysis levels. Participants made a number of observations on this aspect of the policy process.

First of all, the data collected must be screened to ensure that they are both accurate and timely, as noted in Jewett's presentation. Furthermore, participants agreed that it can be wasteful to collect data that are more precise than necessary for the policy analysts. The data should be relevant to the questions at hand, and pared down to the essentials. However, relevant data for specific commodities or sectors may actually be too narrowly focused for policy purposes. In the case of uranium, for example, policy questions can be answered only by considering the overall context of energy requirements and sources, as well as other socio-political factors. It was suggested that the ability to select the right data for specific questions is a skill or intuition that should be valued highly.

The time-span of the questions to be answered also bears consideration. For example, assessment techniques with no built-in time dimension should be used only for short-term analysis, since they tend to assume existing conditions and therefore may well become invalid over the long term as conditions change.

The questions asked by policy analysts can in themselves be a source of confusion in interpretation of data, since different questions or purposes may give rise to differing methods and results. The example of U.S. oil and gas figures was cited, where two government studies with different purposes and using different methods came up with estimates that did not appear to agree. Although both studies were honestly and competently done, the apparent discrepancies in their figures led to a major controversy. (The studies in question were by Hubbert and McKelvey, both of the U.S. Geological Service.)

Misinterpretation of data is also not uncommon. Canada is particularly vulnerable to misinterpretation problems because it is a major producer in an international market. As a result, political and economic changes in remote parts of the world can change the status of Canadian mineral occurrences from reserves to resources, or vice versa, and move existing operations back and forth from profit to loss situations. Similar effects can be caused by internal factors, such as infrastructure availability and costs, interest costs, fiscal changes, and other non-geological factors that can override the technical data of the geological assessment.

In sum, the participants agreed that geoscientists have an essential role to play at the stage of data interpretation in order to ensure that the correct conclusions emerge from the raw data in response to specific questions. This role clearly extends into the presentation of geological information inputs to the policy analysts as well, and a number of observations arose relating to effective ways of presentation of such information. Perhaps most important of all, it was stressed that their presentation should be as brief and simple as completeness will allow.

Geologists and engineers may be accustomed to presenting data to other technical people. However, when their presentations enter the policy process, they must bridge an inter-disciplinary gap, and this calls for a new kind of communication. Data must be in a form suitable for use by the policy analysts, and must recognize the possibility of differences in terminology, training, experience, value systems, time frames under consideration, and even human nature. It may also be necessary to switch from a quantitative to a qualitative emphasis. In other words, scientific communication, as well as science, is required.

The presentation should be designed to be useful in the particular policy context or issue involved. It should also recognize that changing events or objectives may lead to different requirements, and so should offer some degree of flexibility in the way it can be used. Geoscientists should also anticipate data problems which may arise in the future, if they sense that policy analysts or policy formulators are not asking the right questions.

Over time, the geologists and engineers in the business of providing information to the policy process need to build up a reputation for honesty and accuracy, so that their presentations are received with confidence. To this end, and to help protect policy analysts from falling into errors of interpretation, geoscientists should make a clear distinction between historical data and forecasts or projections. The probabilistic aspect of the latter should be very clearly stated and explained. For both facts and forecasts, the definitions, methods of aggregation and interpretation, and underlying assumptions should all be made clear. There is a real need to clarify and explain the difference between reserves and resources, for example.

There was some discussion of advocacy positions in the presentation of information. However, most participants seemed to feel that, while geological or other technical information can and often should include clearly supported conclusions, it should be presented in an objective manner.

Scientists and engineers should try to be relevant and helpful to the policy analysts. In order to ensure that the information they provide continues to be useful, they should seek feedback from the various groups that use it.

It was suggested that 95 percent of the secret of success in science, as in policy analysis, is asking the right questions. Over the course of the seminar, participants raised a number of questions for consideration by geoscientists, some of which are included, in no particular order, below:

- i why is the concept of a diminishing resource base still a basic assumption of policy analysis, in the light of Canadian experience to date?

ii are you aware that the Canadian government's market data are outdated before they are released?

iii how does one compete with third world countries which support noncompetitive copper or other mineral operations?

iv do Canadian firms have adequate cash flows left after deducting royalties, user fees, taxes etc. to survive economic dips and still finance new projects?

v what proportion of Canada's mineral resources could be transformed into reserves (and vice versa) by unilateral action of the Canadian government?

vi do policy analysts recognize that, in constant dollar terms, the long-term trend in prices for some metals, particularly copper, is flat or actually falling?

Government participants were asked about the use that has been made of specific types of technical information that have been presented to the policy process. It was felt that resource assessments have been used for land use decisions, but have had very little use at the overall policy level. Feedback on the use of supply curves suggests that, in some instances, trends or trend changes may trigger a policy response such as encouragement to the exploration sector or incentives for mineral investment. The curves are also used within government in discussions of short-term supply adequacy. For example, export restrictions may be imposed on minerals if domestic shortages are anticipated.

Policy Analysis

In moving from consideration of the interpretation and presentation of information to policy analysis, participants found somewhat less common ground of agreement on the role that geologists and engineers should or do play. It was noted that policy analysis is a very different professional activity from data collection, and some participants suggested that technical people at the analysis level actually function as ex-scientists and ex-engineers. At the same time, however, it was generally agreed that it is difficult in practice to distinguish between data inputs, interpreted information, and analysis. Further complicating the situation is the fact that much of the data input that reaches the analysis level is nontechnical.

In spite of these complications, and to some extent because of them, participants generally felt that there are compelling reasons for scientists and engineers to play an important role at this level. First, by developing their communications skills they can pass on technical information in usable form and thus assist in bridging the interdisciplinary gap. Second, they can use their knowledge in their own area of expertise, and their intuition in broader areas,

to help select the information and data inputs that are relevant to the policy questions that need to be answered. (The use of the word intuition was questioned, however, on the ground that it denigrates the real skills that should be involved in the selection of information.)

Among the other tasks that specifically require technical personnel at the policy analysis level, the following were identified:

i avoiding the mislabeling of figures, as in the case cited in Zwartendyk's paper where outside limit estimates for resources were referred to as 'reserves' of oil and gas;
ii avoiding problems resulting from the summation of estimates, where increasing levels of possible error become incorporated, and the level of uncertainty may not be obvious in the resulting totals;
iii checking data inputs from outside sources for accuracy and relevance;
iv separation of historical data from forecasts, and highlighting the probabilistic aspect of the latter.

Some participants felt that data entering the policy analysis process should already have been preselected in order to draw some clearly supported conclusions. This gave rise to concerns that data that are preselected to support a particular approach might give the analysis a built-in bias. It became clear that the discussion was circling back to the problem noted earlier, that data collection, interpretation, and analysis are difficult to separate in practice.

Decline of Policy Role of Scientists and Engineers

As P.G. Halkett and D.W. Davis both noted in their presentations, the decade of the 1960s saw the decline of influence in mineral policy matters of technical departments of mines in Canada, and the shift of responsibility for mineral policy formulation to nontechnical analysts within mines departments and in central agencies. It was recognized that the widening of policy objectives over the period, to include social, economic, environmental and political ends as well as mineral-related goals, called for a whole range of disciplines within the policy process. One participant (a mining engineer), at some personal risk, suggested that geologists probably had the least to contribute in the changing policy environment. Their contributions tended to be limited to the area of geological resource assessment, which is used chiefly for land use planning. Broader economic and social goals require a broad range of other disciplines and specialists, including metallurgists, marketing specialists, and mining engineers, as well as economists.

Several other instances were discussed that illustrated the loss of influence of technical personnel in mineral policy formulation in provincial goverments, par-

ticularly in New Brunswick. In general, most participants agreed with Dallas Davis' assessment that the loss of influence stemmed directly from the inability or unwillingness of the technical people to accept the broadening of policy objectives and the relevance of nontechnical inputs to the process. The resulting rigidities led to the removal of the technical experts from the mineral policy formulation role, and a shift of this role, in most cases, to central agencies.

A parallel situation was described in the U.S. Bureau of Mines, which lost jurisdiction over energy matters, first to a newly-created Department of Energy and possibly later to the Commerce Department.

The question then arose of who is now making the policy analysis and decisions. Although one participant felt that the majority of central agency staff, in Ottawa at least, are not economists, there was general agreement that economists are representative of the sort of generalist who is now in charge of policy analysis in Canada. It was suggested that economists and other social scientists appear to have particular advantages for this sort of work, in terms of both training and career paths. Since their training is in the social science area, it should equip them to deal with the broad range of variables required by the different objectives that may be built into a single policy field, such as mineral policy. It also includes specific policy-related concepts such as marginal utility, public finance, opportunity costs, marketing, general equilibrium etc. Their career path tends to put them into the bureaucracy and into policy analysis roles shortly after graduation, rather than in mid-career, as is the case for most scientists and engineers. These advantages do not, however, alter the fact that they are likely to have at least as big a knowledge gap in technical areas as scientists have in the institutional and policy areas.

One approach to closing these knowledge gaps, it was suggested, would be an increase in the use of mineral economists in mineral policy analysis. Geoscientists and engineers who undertake further studies in mineral economics, either initially or in mid-career, can combine the best of both disciplines. It was noted that mineral economists are not all-purpose generalists even within their own field; specializations occur between and even within schools, and include such topics as statistics, foreign trade, operations, marketing. Nevertheless, all have considerable interdisciplinary exposure in policy-related subjects on top of their scientific and technical skills.

Whatever approaches are used, it was felt to be imperative to increase the participation of scientists and engineers in the policy process, if Canada is to achieve realistic and workable mineral policies. Much as they are needed, they will have to earn the right to participate, and the trust of the policy analysts already involved. They will also have to learn how to integrate themselves, their expertise and their information into a team approach.

One participant pointed out that the tone of the discussion seemed to be apologetic, with the scientists and engineers apologizing for and accepting responsibility for their declining role in mineral policy formulation. He disagreed, and suggested that perhaps the major fault lies with the bureaucrats who are seeking simplistic and politically acceptable answers to their questions.

In summary, participants suggested a number of other ways in which scientists and engineers could increase their role in policy formulation. These included the following:

i scientists and technical people have to recognize and accept the validity and importance of data inputs and information from other sectors and interests, and the multiple objectives of policies;

ii they have to anticipate and understand the full implications (i.e. economic, social, political, regional, environmental, fiscal, etc.) of the policy options they may present;

iii their presentations have to be clear, simple, and short;

iv their presentations have to be valid, consistent and reliable, so that a feeling of trust for their data and their views develops among the decision-makers;

v they have to understand the policy process, recognize that it is fluid and varies with time, issues, personalities, etc., and develop contacts in order to work within the system to achieve consensus wherever possible;

vi they have to acquire the necessary communications skills and knowledge of other sectors to permit them to close the interdisciplinary gap that is presently hampering the input of technical advice;

vii bureaucrats should seek out scientific and technical advice and analysis wherever it is relevant to the questions that have been raised.

PROVIDING POLICY ADVICE TO GOVERNMENT: THE ROLE OF SCIENTIFIC AND TECHNICAL KNOWLEDGE

by

G. A. Jewett

Let me begin by complimenting the organizers for having the courage to propose a difficult and complex subject; one that has not received, in my opinion, sufficient attention by scientists, be they political, technical, or social. This subject has a broader relevance than that of a provincial government. I propose that the same issues occur in any goverment or in large private sector organizations.

I would like to begin with some questions and then suggest some answers.

First, what is policy analysis? It is a process of:

i gathering and presenting data from which the significant elements are selected;
ii interpreting the data, then communicating the results to the decision makers in the organization.

In a word, it is an intelligence system.

Second, how are the priorities established?

i by the decision makers who establish the corporate objectives;
ii but also by events which may require change in objectives and priorities.

Any system that does not provide for the second eventually courts disaster! It should be possible to demonstrate that in almost any jurisdiction today in Canada there is so much legislation with conflicting objectives and priorities that the system is hopelessly overloaded. For example, should we be surprised that private sector investment in Canada is stagnated when we persist in the belief that both FIRA (Foreign Investment Review Agency) and the capital gains tax are essential elements of government policy? Where we seem to be failing is the lack of recognition that current events require a drastic reassessment of our priorities.

Third, what is required for the system to work?

i it must be proactive - that is, it must be able to anticipate events sufficiently to allow effective response time;
ii it must accurately predict future events;
iii it must be responsive to changing events and priorities;
iv it requires quick, reliable, undistorted communication.

I could also point out that the problem we address here is not confined to government; the problem is very largely one of establishing and maintaining effective communication in any large organization. It represents one of the major problems of bigness, which must be solved if the organization is to retain its effectiveness and survive.

We should also accept that, while the problem of using scientific and technical knowledge in the policy process is no different from that for any other discipline, much of the subtlety of concept we understand is usually lost because we deal in quantifiable concepts and the world tends to grasp these as understandable and ignores the subtleties as 'confusing'.

I also wish to point out that scientists and engineers frequently make the mistake of ignoring the human aspects of an issue because they are not quantifiable. Without attention to this reality, the translation of scientific knowledge into effective action is usually impossible. This, in part, is the role of the politician, but without adequate comprehension of increasingly complex issues, his decisions are likely to miss the mark.

Brian Mackenzie has stated that, in the last decade, in Canada 'mineral policy has received a considerable amount of attention. Unfortunately, results generally oscillate between broad 'motherhood' statements of progress intentions on one hand and the implementation of restricted, unconnected policy mechanisms on the other. A general, but meaningful mineral policy framework between these two extremes has not yet been revealed.' Very regrettably, this statement contains too much truth for comfort and for the well being of all Canadians.

I could develop a description of the mineral policy process as it exists in Canada today, but I hardly think that would be useful; too much of the problem is human and political. Rather, by identifying the essential role of scientific and technically trained people in policy analysis, perhaps we can identify how the process can be strengthened and made more effective.

Fourth, what is the nature of information required for mineral policy formulation?

To answer this question, it is important to recognize that we are dealing in a 'futures' exercise, and, just as important, that policy analysis is a continuous process in the fluid environment. Historical data are useful only if they help us to understand how events are 'flowing'.

Surely an essential objective of the policy system is to correctly anticipate future events, or the impact on the future of current proposals. Management with this kind of 'intelligence' is thus able to condition the organization to respond and benefit from future opposition, and to prepare for future challenges.

The concern of the scientist or engineers in the process is the extent to which the realities of their science can be communicated and understood by the policy makers. We must accept the fact that failure of communication of scientific or technical realities will almost certainly result in failure of the policy process.

Since so much of the policy process deals with future projections, economists have assumed a major role in the 'art'. However, effective forecasting depends upon a real understanding of the industry and its markets, along with the ability to recognize new influences on the market, be they geological, technical, or market related. For example, any attempt today to predict the future trends in the iron ore industry on past data would be a sure formula for unsound policy. Yet the fact that the industry is at a 'break point' on two fronts - technology and marketing, would most likely only be evident to a person who is sensitive to industry intelligence.

Thus the role of the scientist is to interpret facts and communicate the realities to the decision makers and, if somehow these realities are misplaced or ignored, the process will fail.

However, to communicate is not the whole story; one must also question the type of technical and scientific data required for effective decision making, and then relate these to the collection and presentation process. The requirement is of course for facts - the building blocks of any decision process, but these facts must be <u>accurate</u>, <u>timely</u>, and <u>relevant</u>.

In no area of business is accuracy so vital and the results so pervasive as the policy-making process in government. If a major policy analysis is based on incorrect data or on incorrect or incomplete interpretation of data, then, while

the product may be persuasive, the results can be disastrous to a whole economy. Unfortunately, I don't have to cite examples today; I am sure you each can find your own.

Fifth, how is accuracy achievable in the policy process?

It is necessary to separate fact from fiction! That is to say that historical or raw data should be presented separately from any data which has been subject to any kind of interpretation. Any derived or interpreted data will almost certainly include someone's bias and possible error. Thus it is important in the policy process to make a separation between historical and projected data in the presentations, or between known and potential resources.

I have also said that, for policy analysis to be effective, it must anticipate emerging policy issues or opportunities. It would thus seem to be axiomatic that effective policy analysis is only possible if it correctly anticipates future events. Yet too often we see uncomfortable facts or issues ignored in the process of development of Canadian mineral policy. Uncomfortable or troublesome as it may be, it is essential that <u>all</u> the relevant facts be presented to the decision maker if he is to fully comprehend the issues. The scientist or engineer involved in the process must be willing and able to accept this responsibility.

Also, in talking of accuracy, it is important to distinguish between accuracy and precision. A fact commonly ignored is that policy analysis rarely, if ever, requires data that are accurate to more than one, or at most, two figures. Collection of more data than are required or that are too precise is wasteful, but perhaps more important is the time loss in their collection and preparation which leads to the next concern, timeliness.

To be useful for policy analysis, data must be timely and current. This is particularly important in a cyclical industry where the period between peaks in the cycle can be as little as two years. In such an instance, I would suggest that this means that the absolute maximum between the time data are collected and presented must be three months. If policy analysis is to be effective and is to recognize the fluid nature of our industry, then quarterly reviews and updating will usually be required.

Lastly, however accurate or current, data can serve no useful purpose in policy analysis if they are not relevant to the issue at hand. Data must be 'sorted'. The process by which this is to be established requires insight and broad understanding of the industry. Somewhere in the process the required skills must be present to do this if the decision makers are not to be buried under a tidal

wave of facts. Without significant sorting of data, credibility is just not achievable and, perhaps more important, communication is impossible.

It would appear to be obvious that, only by very great clarity of thought and communication of ideas to the decision makers, can there be any hope that the decision makers will recognize the realities and special concerns of our sector of the economy, or any other sector for that matter. Unfortunately, this clarity is not common today - at least in our society.

However there is also another need for communication. Ideas, realities, and priorities must all be communicated to the people in our democratic system. It is unrealistic to assume that the decision maker, the politician, will relate to priorities that do not have the acceptance and support of the general electorate.

To remain effective, scientists have to communicate to the decision makers in government and in industry, but if they don't also communicate the facts and realities to the public, the electorate, then they should express no surprise if the system demands and gets poor policy. Focus, is of course, an essential requirement if such communication is to be possible.

The challenge for scientists and engineers is mainly to rise above advocacy and to identify with great insight those facts and factors which must be accommodated in any effective policy be it corporate or governmental and then to communicate broadly! That it not easy! A good example of what I mean by 'focus' would be the following graph (figure 1).

I thus agree completely that the primary rationale of any organization chart with mineral policy responsibilities is to identify emerging policy issues, analyze these issues quickly and comprehensively and communicate the realities of the analysis to the appropriate decision makers. That is the essence of the task!

I would like to now address myself to the particular role of scientific and technical knowledge in this process. Perhaps a few examples would help. In resource appraisal, in the geological area, there has been in the past much too much 'mumbo-jumbo' intended to prove that the resource base of the world is diminishing. The reality of course is quite the opposite. In the ten years since Limits to Growth was published, this point has been made by many, many academics and scientists much more capable than I. Yet the realities have not been communicated to the electorate in any of the democratic societies nearly as effectively as the orginal concept.

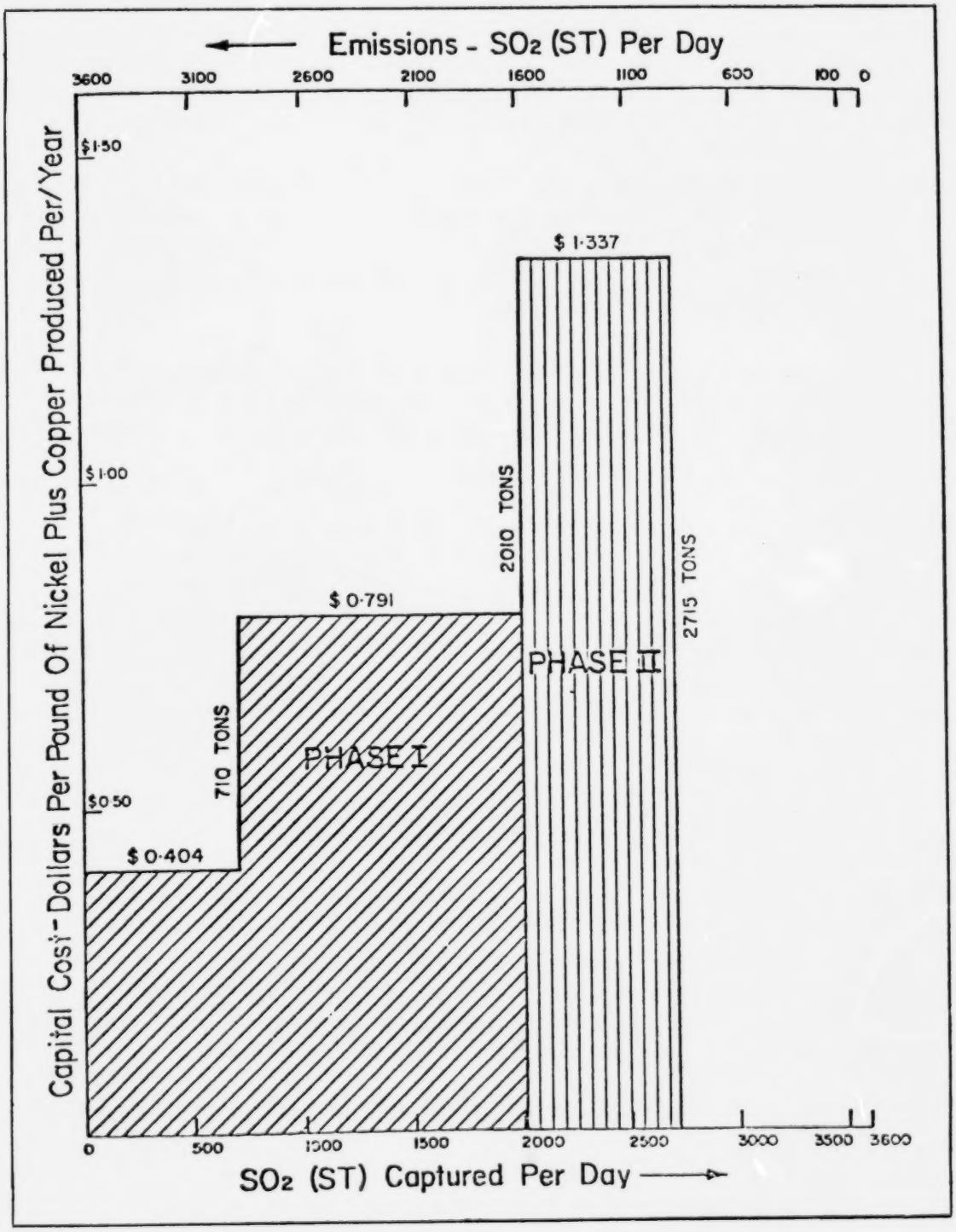

Figure 1. An example of 'focused' information, clearly presented.

Consequently we still find policy being based on the assumption that we are dealing with scarce resources for which the market is prepared to 'scramble'. As we all know, the reality today is the exact reverse, yet we still see policy documents coming through based on this assumption.

Another focus for concern is in the planning process, determining how to plan for the unpredictable. We have in our experience many useful exercises of this type, but the role of the geologist is most essential in ensuring that the significance of resource data, its limitations, and the separation point between hard and soft data are correctly understood.

Geological data required for policy analysis are most frequently information about the resource base, yet we know really very little about how and why mineral deposits are formed. Without such knowledge, any estimate of potentially available future resources is speculative at best.

Along with biology, geology is at a most exciting stage of scientific development, comparable to physics sixty years ago. However, in mineral policy formulation, we need to know a great deal more about the natural processes of mineral concentration than we do today, in order to be able to forecast mineral occurrences or discoveries with any degree of reliability or credibility. The use of data on potential or possible resources in mineral policy analysis is today a shifting sea of illusion and deception. The question today is: can sound mineral policy be based on anything but known or proven resources?

Another requirement is a practical understanding of the mineral market and, most important, the significance of change in mineral markets.

If mineral policy does not recognize that the market does not 'care' what it costs to produce metals, and that market decisions are made on expectations, not fact, and that the market 'waits for no man!', then the process has failed to recognize some essential realities. Again we need in the mineral policy process people that do recognize these realities and can communicate them effectively in the context of the policy-making process to the decision maker.

We need to recognize that, for policy analysis to be effective, someone must sort out of a large mass of data that which is significant, interpret it correctly, and communicate the interpretation effectively. This skill is not described in any literature with which I am familiar. It is not only 'intelligence'. It is not only 'experience'. Although these things are helpful, they are not an absolute requirement. I prefer to call it the 'Einstein factor': the ability to sort quickly a large mass of data, and to recognize intuitively as well as logically that which is significant, and then to be able

to identify the significant relationships. I wish to make the point that this skill is precisely the skill that makes a 'great geologist' or a 'great researcher'. It is not common, nor can it be taught; either it is there or it is not there. Every policy organization needs to have a few people with this skill and needs to use them well, but how can this be done, particularly in a large organization?

Dr. Mackenzie has suggested a policy organization that is three-tiered, separating the information system, the data assessment system, and the policy analysis process. Concepts such as these are common in any large organization, be it corporate or governmental. Unfortunately, there is a need to communicate effectively and maintain absolute linkages through all layers of the organization, and this can be a critical weakness. One must face the question as to how to organize so that something is not lost in every step of the communication process. Again let me repeat that the system must ensure that the information transmitted is accurate, current, relevant, and focused as well! Also the organization must recognize the need for scarce skills and use such people sparingly and effectively.

Any analysis of such a system must recognize certain realities. Firstly, there is a loss in any transmission of ideas or instructions. It is extremely difficult, if not impossible, to ensure that any idea or instruction is not distorted in communication through several intermediaries. Why is this?

To ensure accuracy in transmission it is necessary that the person involved at each succeeding level must:

i be able to communicate in a common language;
ii be fully briefed and have access to all relevant facts;
iii have an equal or better awareness of the subject, its complexities and its subtleties;
iv have the same view as to how the subject in question is related to objectives and priorities;
v completely sublimate personal priorities, and have the courage and conviction to preserve objectivity and accuracy.

Sixth, is it reasonable to expect any organization to maintain accuracy of communication through more than one intermediary?

The problem in any large organization is the need to reconcile a multiplicity of objectives and options. Usually a system is established to deal with the mechanics of choice of many departments. Regrettably, however, the system can dominate, and this frequently inhibits undiluted communication of technical essentials.

The common experience is that we arrive at a 'watered down' or distorted version of policy analysis that has all the aspects of motherhood with which we are too familiar. In an organization such as this with three distinct functional levels, one should expect that issues presented to the decision makers would have a lack of focus as a common denominator. Can the model be improved? I suggest it can, but that perhaps we have to look abroad for our enlightenment.

In North America, business appears to have rejected the conglomerate approach and to be going back to a focus on corporation specialization. I suggest that implicit in this is the recognition of the importance of specialized knowledge in business decisions, and the role of the specialist in the management process. Yet business here still has a way to go. Are you aware of any corporate takeovers which were preceded by a scientific or technical audit of the firm? Financial yes, market possibly - but scientific! - not likely. For example, one has to wonder, given Allied Chemicals' discovery of the potential use of plastics in battery design, whether a scientific or a financial audit of the battery business would have been more useful for effective decision making, before investment in a metal-based battery business?

Governments generally have failed to recognize the scientist as anything more than a curiosity. Useful sometimes, it is granted, but in reality not an essential part of the organization. Governments are still using and introducing management concepts that were rejected by business ten years ago. The explanation for this, I believe, lies in the concept that a senior career civil servant must be a 'generalist', and administrator is another word that is frequently used. The organization that emerges ensures that there are several layers of administrators between the scientist or engineer and the decision makers; and that administration generalists sort and sift policy analysis on its way to cabinet. In this circumstance a 'grey product' is guaranteed!

I think it only fair to say that small governments have had some success in avoiding this problem, and thus it is only fair to ask whether the problem is essentially one of bigness? I think not! Some large corporations have solved this problem. If they don't, they don't survive in today's technical world. It would appear that the North American auto industry has come perilously close to being a most recent example of the penalty in business of not meeting this challenge.

However in Japan, where bigness seems to be the rule, judging from performance in both the government and business sectors, bigness does not appear to have been a problem. I don't claim to be an expert there, but I am told that motivation of the individual within a strictly disciplined hierarchy is a common denominator in the Japanese model. That can't be all! From the results one

would judge that somewhere in this system the Japanese must have solved the problem of learning to access scientific and technical knowledge in the decision process without distortion. It would be interesting, in fact it is essential, that we find out how they do it, and then copy it!

Successful solution of this problem in western world government is essential in this scientific age. We need a process that actually sets priorities and then communicates them. We need a system of communication within government that ensures that duplicate circuits exists. That is, there are at least two ways for ideas to reach the top. We need to interject into government management systems organization concepts that permit the scientist and engineer to present analysis with clarity and lack of distortion to the decision maker at the very top.

Is there any simple or clear solution, or model?

Looking at the model, could we consider the following as feasible?

i Combine the policy analysis and the policy interpretation functions into one group.

ii There would have to be several such groups.

iii Keep the groups small but staffed with acknowledged scientific, engineering and marketing experts with the full range of skills required to identify and interpret mineral policy issues.

iv Make sure the groups are interactive.

v Make sure the groups are properly motivated.

vi Ensure that each group has complete access to all data input relative to the mineral industry in the government system, however privileged.

vii Ensure that, at the top decision level, someone is present and involved with the scientific training and wit to identify, in any issue, which of the scientific groups at the second level should be consulted; and then that he has the power to bring the proper person before the decision makers to present his group's interpretation of the issue without delusion, distortion or bias.

If the answers to the above could be positive, then perhaps the scientist and engineer in government would have at least a chance to ensure that policy decisions were informed decisions, and that the policy makers were advised of emerging policy issues with clarity and focus.

It is clear that we have a real problem of catch-up, if we are to survive in this highly competitive world where progress is based on scientific and technical knowledge, and where a principal competitor has demonstrated a superior capacity to use scientific knowledge in both business and government.

I suggest that there is at least one model in our recent experience that did work: that is the British government under Churchill in World War II. This government seemed to get its priorities right, to maintain excellent communication between its scientists and the cabinet, and most important, to be effective. The contrast with Germany, which did not suffer from lack of scientific capability and imagination, is striking. I refer you to the book Most Secret War by R. V. Jones and suggest that there is an analogy between policy systems in government then and now. Both need:

i large masses of raw data to be sorted, with rapid accurate interpretation;
ii accurate communication of scientific realities and issues to cabinet.

The book is full of examples that demonstrate an organizational ability to transmit undiluted fact to the war cabinet within hours, never days! What is curious and significant is how any organization could be so large and still be so flat, at least when the CEO (Churchill) wanted it to be.

It worked then, why not now? The answer is that there are problems which remain to be solved for such a system to work effectively. It is absolutely essential that top management believe in and understand how essential accurate scientific intelligence is to their 'business'. Certainly the establishment of priorities in World War II was simpler, but essentially the problem is the same today: management has to have the courage and imagination to identify specific priorities and then create a very special organization to provide the information it needs for effective decision making.

It is recognized that, in any system, management will need a wide diversity of specialized knowledge in several fields. In addition, it is clearly essential that each field has, both at the data collection stage and at the interpretative stage, scientists or specialists with the wit to analyze, interpret and communicate the data effectively and accurately to cabinet, and furthermore that they be given the opportunity to do so.

It is also essential that these people be recognized and be given the opportunity to communicate to the management group at appropriate times the essentials of their analysis. Without such access, management then has to fall back upon more traditional organization structures which are more expensive, slower and less effective, but are admittedly much less troublesome.

You will see in the book by Jones that the organization could not and did not succeed the change of government in Britain in 1945, in spite of the fact that it was an organization which did most capably identify emerging policy issues,

analyzed these issues quickly and comprehensively, and communicated the results of the analysis to appropriate decision makers quickly! It would seem to be clear that the organization was a personal thing, a Churchill creation. Unfortunately, the organization was unconventional, it was delicate, full of personality conflicts, and defied rational analysis or any form of measurement.

For these reasons, such a system is seen by conventional standards to be unstable and unworkable, distrusted by all mortals who do not understand science or technology. Because it requires very special status and treatment, such an organization would wither in a conventional management system, unless management were able to ensure its preservation by the selection of succeeding chief executives who recognize the importance of science.

There is perhaps an analogy here to a very delicate flower. We need to recognize the species and the special, unique, environment required for it to flourish, and then we need to recognize that in business and in government we are faced with the challenge to develop a hardier species.

In conclusion, I suggest that our standard of living in the western world will depend on our future success in developing here a better, hardier, system of management that does recognize the need for informed current scientific and technological input, and succeeds in inserting it into the management process. However I conclude that this will not happen until the need is recognized at the top.

THE ROLE OF SCIENTIFIC AND TECHNICAL KNOWLEDGE IN MINERAL POLICY FORMULATION: AN INDUSTRY PERSPECTIVE

by

Herbert D. Drechsler

The subject of this seminar is 'The Role of Scientific And Technical Knowledge in Mineral Policy Formulation'. I would like to begin by considering the process of policy and policy analysis as it applies to the role of economic and technical information in policy making. It would be useful to discuss:

i what is public policy;
ii the process of policy analysis;
iii the types of policy and what comes first, the policy or the data;
iv data collection, its purpose, and who does it;
v what is the industry role.

Public Policy

We can say that public policy is whatever government chooses to do or not to do. There are a lot more elaborate definitions than this, but I think we are starting at the point that policy is a value judgment on the part of those who form the government. Furthermore, policy is designed to alter human behaviour. We talk about human behaviour in terms of individuals, or in terms of corporations. Mineral taxation policy for instance, is one of the public policies that is designed to either encourage or discourage the movement of corporations into the act of finding mineral deposits. Mineral safety policy is likewise designed to encourage or discourage individuals and corporations to work more safely. Thus, we can say that policy is that authoritative allocation of values for the whole society and public policy is the application of those value judgments to the mass of people within the society.

One of the concepts underlying allocation of values is that there should be a goal or objective in public policy. It is not always correct that there are goals in public policy. Often the allocation of values involves simply personal biases applied to the society. Government actions do not need to be applied toward goals in order to be labeled as policies. As a matter of fact many policies have no objective, but are solutions or the means to an end without having an end in sight.

Policy Analysis

Public policy, then, is an allocation of values in the greater society. We shall now move a step further and define policy analysis. Policy analysis is involved with explanation rather than prescription. Second, policy analysis involves a regular search for the causes and consequences of public policies. This search involves use of scientific standards, and may involve sophisticated quantitative techniques, but not necessarily so. Third, policy analysis involves some effort to develop and test general propositions about the causes and consequences of public policy. Fourth, policy analysis may accumulate reliable research findings of general relevance. It is at this stage that analysts attempt to develop general theories about public policy which are reliable and which apply to different government agencies and different policy areas.

There are some very significant problems with policy analysis. First of all, it is not always clear what is government policy, and whether government policies can effectively alter human behaviour in the direction that was anticipated by the policy maker. Second, policy analysis really cannot offer solutions to problems when there is no general agreement on what the problems are. This becomes especially important when we impose values on the mining industry and try to alter the behaviour of the industry. We may, in fact, create problems rather than take existing situations and solve problems. This is a basic weakness of policy analysis. Third, policy analysis, to a large extent, deals with subjective topics and must rely upon the interpretation of the results. Therefore, the conclusions depend on who does the interpretation. Finally, in dealing with policy analysis, we are really dealing with social science rather than engineering science. Social science research is not value-free and therefore the selection of particular topics for research is biased.

In a broad sense, policy analysis is defined as any type of analysis that generates and presents information in such a way as to improve the basis for policy makers to exercise their judgment. We are using the concept of analysis in the most general sense, which implies the use of intuition and judgement, as well as detailed examination of policy by analysts. Analysts, of course, analyze the components of policy and develop alternatives for the achievement of that particular policy. The quality of alternatives is not always easy to measure, and in any event, policy analysis does not imply anything about quality. In the sense that we are discussing now, policy analysis is the process and not the product, and we must distinguish the process from the product. The product of the policy analysis is not the concern of the analyst.

Types of Mineral Policy

Mineral policies can be divided into four types:

i regulative, regulating such things as health and safety or the environment;
ii organizational, organizing such departments as Energy, Mines and Resources;
iii distributive, such as some of the agreements between provincial and federal governments for the development of knowledge or the economy;
iv extractive or taxation policies.

Mineral policy analysis, then, is that analysis which in some fashion provides the decision makers in the legislative branch of government with more information on these four elements.

Data Collection

The role of data and information in policy analysis is to provide the analyst with sufficient knowledge with which to analyze policy. Of course there is a hierarchy between the data and the policy. Data are quite far removed and at several levels from the policy. Raw data are just input to information, which in turn is input to analysis, which then will help policy makers make a value judgment, and that value judgment may in some fashion alter human behaviour. More particularly, at this conference, we are concerned with scientific data input of the geologists and mining engineers to aid the analyst in providing information to policy makers.

Heirarchy of Objectives

Within each one of these four types of policy, an objective usually is formed. In fact, there is a hierarchy of objectives. We will call the first level the ultimate objectives, or the higher goals of the policy. These often are vague, but constitute the fundamental absolute and utmost objectives. They usually tell the expected outcome, but without time dimension or specified criteria for measuring the objective or organization that will do the measuring. This type of objective generally forms ill-structured problems.

The next lower level comprises what we shall call the regional objectives. These provide the link between the ultimate objectives and even lower level objectives which we will call operational objectives. The regional objectives specify the outcome to be achieved. They list the criteria to measure the

outcome and describe under what conditions they would be measured, but do not specify the organization that will do the measuring. Most often these objectives also form ill-structured problems.

Finally, there are the lowest level objectives; the operational objectives. These objectives specify the outcome to be achieved, when the outcome is be to achieved, what are the criteria used to measure the achievement, under what conditions, and by whom. These problems usually are well-structured, so that a solution or effective policy can be found.

Policy Alternatives

This policy model assumes two points that are in different locations. One point is the starting point, which is where we are now. The other point is the specified objective, or where we want to be. The means to reach the objective from the starting point are the policy alternatives. When either or both points are not precisely stated, we have an ill-defined problem or ill-defined policy and these types of problems cannot be solved. Furthermore, if the specifications for the starting point and the objective are at different hierarchical levels, we cannot close the gap by selecting a policy alternative which will achieve the objective.

We then develop a series of key questions even before we are concerned with data evaluation in the process of policy analysis. The two questions are: where are we now and where do we want to be. These questions must be equally specified and be at the same hierarchical levels. If both questions can be precisely answered, we can then begin to obtain and process the data for the analytical portion of the policy analysis.

Mineral policy problems typically involve complex situations with intersections of both scientific data and judgment of experts. The use of data implies quantitative analysis. Policy analysis could become completely quantitative if the policy under investigation could be fully described by a mathematical model so faithfully that a decision may be made purely on the results obtained from it. Scientists tend to believe that quantification is the means for becoming more scientific and rigorous. The data accumulated by the geologist or engineer often are scientific, rigorous data which are utilized in quantitative models. I have accumulated such data working as an engineer and know that often the process of data accumulation is an art, rather than a scientific process. I assume that the geologist also finds a similar situation. Eventually, in almost all situations of policy analysis, we find that the quantitative analysis fails, and subjective judgment finally gives us the answers. The reality of data input is

that judgment and intuition permeate all aspects of policy situations in which complex human behaviour problems and mathematical problems cannot treat all aspects of the problem.

The data are collected by technical analysts using their scientific and technical knowledge. The data are then used to form basic analytical models and these are applied to policies in a fashion which involves the intuition and judgment of the policy analyst or varieties of experts. It is obvious at this point that policy analysis is critically dependent on the use of judgment. This judgment ranges from the form of the mathematical model used to analyze particular problems, to the decisions of which problems to analyze, and to which data to include in the problems to analyze. Eventually, all models rely upon expert judgment and intuition. It is generally believed, and we have no reason to doubt, that the more expert the judgment and intuition, and the more systematically and efficiently applied to problems, the greater the likelihood that the solution or the policy option which is developed will be sound and will alter human behaviour in the expected direction. We can then say that the role of scientific and technical knowledge is to blend with intuition and judgment in the process of policy formation. The resulting product, which is based both on data and on the judgment and intuition of experts, should be more efficient, and more sound than policies based on other methods.

Industry Participation

Industry participation in developing this data base for scientists to use in policy analysis is crucial, because in many cases it is the industry which develops the data itself from which policy judgments are made. It is becoming more clear that the data accumulation systems of the government are becoming more and more effective, especially in accumulating data on commodities. However, in the field of scientific research it is still the companies that are far in the front of government researchers in the acquisition and utilization of data. It then should be the responsibility of industry to provide the information to government policy makers from which government can develop intelligent policies.

The problem with these 'intelligent policies' is that they may be contrary to the best interests of the industry, since the policy makers are making the policies from the point of view of the government and not of the industry. And of course there is an underlying problem if industry is providing the data, because industry usually does not know the ultimate use to which data will be put.

Often, data which industry has provided have been used to the detriment of the industry. It is almost an adversary role, with industry and government at

opposite poles in the use of policy-oriented data, especially in situations concerning the distribution of income or the cost of operations.

Industry has a primary obligation to provide safe, hospitable working places and to provide wages which are acceptable within the norms of society. Government has a responsibility to gain income which will fund whatever policy decisions are made by the policy makers. The source of such income often is the companies themselves. Where the source of the data is the companies, we may find ourselves in an adversary relationship, with industry and government often at odds on the accumulation and use of data, because of mineral policies which the industry believes will adversely affect its operations, and which may alter direction in which the industry may want to go.

We may now summarize. Public policy is whatever government chooses to do or not to do: that is, an allocation of values in the greater society. Policy analysis helps us proceed from where we are now to the objectives of the policy. However, policy analysis fails if it does not include the intuition and judgment of participants of policy action. Industry is often the supplier of data to analyze and develop mineral policy. However, industry and government often are at odds in the accumulation and use of data because mineral policy derived from that data can conflict with industry objectives.

THE WIDENING GAP: THE LOSS OF TECHNICAL INPUT IN POLICY ADVICE: A PROVINCIAL VIEWPOINT

by

Philip G. Halkett

My point of view on this topic is that of a political neutral, an output-oriented bureaucrat, who has worked in four central agencies in two provincial governments. All of these jobs were in the natural resource/economic development field with the largest stretch being as a staff member to the Executive Council in Saskatchewan with involvement in uranium and potash policy issues. It is this stretch, covering the years 1975-79, from which most of my observations and conclusions on the topic are drawn.

I start with an historical outline of the changing responsibilities for policy advice, followed by two case studies which support my thesis that the specialist has been and will continue to be left behind.

Since central policy and planning agencies form a large part of the topic, I start by offering the following observations:

i central agencies are, and should be, viewed with great suspicion (unless of course you work for them);
ii generally staff of such agencies lack practical (sometimes called real-world) experience;
iii oftentimes staff of these agencies have the habit of not letting technical facts interfere with their desired conclusions;
iv by and large, staff of central agencies are confident to the point of arrogance; they are extremely reactive to every comment from upstairs, but totally deaf to pleadings from line agency staff.

If these observations contain more truth than fiction, then why do central agencies with responsibility for policy and planning exist at all?

I submit that they have been created because people with strong technical or scientific background in the mineral field, be they geologists or engineers with their traditional 'resource management' responsibilities, have not been able to communicate effectively with the decision makers, nor respond in a holistic sense to the mineral policy issues of the 1970s and 1980s. These policy issues are largely social, economic and environmental in nature and are defined in political terms or even slogans. I further argue that it is this inability of

the specialists to adapt to a changing environment which has given rise to central agencies with their strong influence over policy in general and mineral policy in particular.

Twenty years ago it used to be a 'Director of Mines' (usually a mining engineer) who defined, set, and implemented mineral policy. He had control of and influence over all the key policy levers - tenure rights, royalty regimes, and safety and environmental inspections. His colleague, a 'Director of Geology' (usually a geologist), had control over the collection, compilation, and dissemination of large-area geological data, a necessary element for encouragement of private sector exploration activity. These two individuals usually communicated very effectively; they were trained in the same schools, had the same value system and probably had adjoining offices.

But times changed, and as the politicians, forced by public pressure, came to see mineral exploration and development as having many nontechnical dimensions, a layer of policy analysts, attached to the traditional Ministry of Mines, came into existence to act in the role of interpreter and synthesizer between the politicians and those who traditionally had policy responsibilities. The split was made, and the important dimensions of mineral policy went to the new group, leaving the other group with the data gathering and implementation duties. With this break, lack of communication between the two groups became an issue, and in some situations still remains an issue today.

Communications became a concern because:

i the group which lost responsibility was deeply offended and was not going to be seen to be cooperating with the 'new guys' on the block;
ii the group established to design policy was proud of its new responsibilities and influence and did not feel it needed the established group;
iii the two groups had, to a large extent, entirely different academic training, different concepts about the same resource, and spoke entirely different languages.

Structurally, the policy analysts, while exerting a 'central agency' influence over the traditional group, were at least attached to the same 'Ministry of Mines' and reported to the same senior manager who reported in turn to the minister. This senior manager could, theoretically, force the two groups to come to terms and work together on important policy issues.

But times kept changing, mine development became more multi-dimensional, and even this expanded 'Ministry of Mines' was found to be lacking, giving rise to what are 'true' central planning agencies, meaning agencies with no reporting

relationship, at either the bureaucratic or the political level, to the 'Ministry of Mines'. (They go by different names across the country, examples being the Privy Council Office in Ottawa, or Planning and Research in Saskatchewan).

If communications were difficult between the two groups in the 'Ministry of Mines', they were even more difficult between anyone in the 'Ministry of Mines' and staff of the central agency. The proximity of these new policy analysts to the decision makers on a regular basis, and the fact that the central agency's responsibility was to produce plans and policy, left both groups in the 'Ministry of Mines' at a disadvantage. Friction and disagreement between policy advisors in the Ministry of Mines and in the central agency were often worse than the disagreements between the two groups in the Ministry of Mines, even though both groups of policy advisors had similar training and background.

To complete my picture, let me add to our two groups (i.e. the 'Ministry of Mines' and the central agency with policy and planning responsibilities) another influence-peddling agency which often has veto power over the design of important mineral policy instruments. I'll call this agency the 'Ministry of Finance', and refer to it again in one of the case studies.

Paralleling the organizational and responsibility shifts for mineral policy of the last 20 years at the bureaucratic level have been changes in the structure of the decision-making forum. When our specialist the 'Director of Mines' was the key bureaucrat in mineral policy development, the policy decisions were taken by the minister responsible. By the end of 1977, however, the important mineral policy decisions in Saskatchewan were being taken either by the Planning Committee of Cabinet chaired by the Premier, or by the full cabinet. In British Columbia at the present time the Cabinet Committee on Economic Development is the key cabinet committee, and it makes recommendations either to the Planning and Priorities Committee (chaired by the Premier) or to full cabinet.

In Saskatchewan the Planning Committee of Cabinet had its own staff of policy advisors (Planning and Research, mentioned earlier), while in British Columbia none of the cabinet committees has its own staff, relying instead on the policy analysts in each of the ministries represented on the various committees.

From this historical perspective I conclude that the specialist, be he geologist, mining engineer or metallurgist, has lost his position of influence at the decision-making table. Two case studies drawn from my own experience further support this position.

The first case has its setting in Saskatchewan in early 1975, and deals with uranium, specifically the Amok development at Cluff Lake. The development of

the mine from the first hint of a discovery in 1969 up to 1975 had been handled, on the provincial side, by the traditional Director of Mines. In early 1975 a policy analyst attached to the staff of the Cabinet Planning Committee asked the Ministry of Finance to determine whether the development was 'profitable'. The Director of Mines had made his first tactical mistake. He had assumed that the old mineral royalty system which had been in place for many years, and which he had helped to design, was adequate for the new development.

After the analysis, the decision was taken that changes in the system were needed. The Director of Mines, because he was defensive about the existing system, was not party to the design nor implementation of the new system. Among the immediate consequences for his ministry was the suspicion that other mineral policy advice from the ministry was suspect.

The new uranium royalty was designed initially by the Ministry of Finance and was approved by another cabinet committee, the Treasury Board. It was then passed to a newly-established central agency called the Energy Secretariat, which over a short period of time inherited significant influence, if not complete jurisdiction, over uranium and oil policy matters.

Few things are as dramatic as disagreement between two central agencies, and disagreement there was, on the subject of the new uranium royalty system between the Ministry of Finance and the Energy Secretariat. Rather than accepting the system, the Energy Secretariat undertook extensive analysis of the proposed system and then entered into a long series of discussions with the firms in the uranium industry. These discussions provided valuable information on a wide range of matters, including investment and operating cost scenarios which were likely to occur in new deposits, and resulted in significant changes to the system as originally designed. As a result of policy proposals put forward to the Cabinet Planning Committee, the Energy Secretariat received direction on road access, local employment and local purchase issues. The traditional specialist with responsibility for mineral policy was nowhere to be seen.

When the substantive and holistic issue of a public inquiry into the industry began to take shape, the ad hoc team assembled to develop proposals for terms of reference, etc., did not include anyone, who, two years beforehand, had had responsibility for mineral policy. The failure of the specialist to respond to the less significant policy issues had the unintended consequence that, not only had a new apparatus been set up to deal with these minor issues, but also his right to be involved in this major uranium policy issue had evaporated.

My second case also has its setting in Saskatchewan: the year is 1977 and the resource is potash. I think this case is less damaging for the role of the spe-

cialist, compared to the previous one. By way of background, the policy decisions with respect to the provincial tax on the resource (the Reserve Tax) had been taken in 1973 and the decision to acquire 50 percent of the productive capacity had been taken in the latter half of 1975. A provincial election had been fought and won largely on the resource development policies of the government, with potash being the most talked about resource.

The Reserve Tax had been designed and implemented largely by a branch of the Ministry of Mineral Resources, called the Potash Management Branch, staffed by persons whose formal training was in engineering. To remain intra vires the British North America Act, the tax was designed to be a direct tax on the value of the plant and orebody. To reflect the differing physical characteristics of the orebody, various factors such as ore grade factor were built into the calculation.

In 1977, a group of policy analysts in Planning and Research (which as has been mentioned was a central agency reporting to the Planning Committee of Cabinet) initiated a study to determine whether or not the Reserve Tax had odd and unacceptable behavioural characteristics as claimed by the industry.

After considerable study, the conclusion was drawn at the staff level that many of the 'structural' criticisms of the tax had merit. Reflecting a case of role reversal, the central agency analysts went to the line department staff to have their analysis judged. The line department staff were reasonably supportive but not sufficiently enthusiastic to take any action.

The central agency staff then, in isolation, drafted a straightforward (layman's) analysis of the deficiencies of the Reserve Tax and a set of policy options as to what type of payment structure could replace the Reserve Tax. After discussion with certain cabinet ministers, both individually and as a group, the decision was taken to replace the Reserve Tax and, after considerable effort by many people, this was accomplished.

Shortly after the decision was taken to replace the tax, the central agency staff did extend an invitation to the line department staff to be part of the 'team' implementing the decision. The team approach was successful, though the leadership throughout the implementation period remained with the central agency staff. The departmental specialists with the responsibility for mineral tax policy, having once not responded to an initiative which was offered, lost, unintentionally, the lead in implementing the mineral policy decision which resulted.

By way of a conclusion, if the technically and scientifically trained person is increasingly being placed, by circumstance, further from the decision-making table, how might this situation be altered? Is our hypothetical 'Director of Geology' faced with a future consisting solely of producing geological maps, or can his perspective be brought to bear on the broader issues?

I have given some thought to this question and would ask you to consider and respond to the following suggestions.

1. Technically and scientifically trained persons, rather than choosing to ignore policy issues (as I have often observed), have to take advantage of any opening to bring their considerable knowledge to bear. Policy development, because it is politically sensitive, is far too often undertaken behind closed doors. The right to be involved is always, in my experience, earned. Flowing from my own experience is also the firm conviction that you have to start with the 'small stuff'. You have to respond on small issues, demonstrate a capability to deliver a sensible, straightforward product, and work up from there.

2. This flows into my second point, which is that most policy advice is based on the element of trust. Put in straightforward language: is the judgement of the person providing the technical input trusted? This use of the word trust should not be confused with the concept of always telling the central agency staff or the decision makers what one thinks they want to hear. On the other hand, there has to be a large amount of trust and a history of honest dealings before you can successfully 'sell' a new policy perspective which you know is counter to the current policy.

3. My third suggestion is that, notwithstanding a person's technical or scientific background, policy analysis and policy option papers have to be written in very clear and straightforward language. Too often (and this applies to all disciplines, mine included) I have seen policy papers which use language unique to that discipline and which are far too lengthy.

4. My fourth suggestion is for the specialists to appreciate that any policy, and this includes mineral policy, is really a set of policies trying to accomplish many objectives. There are, at least in my experience, no longer any policies with single objectives. The obligation on all disciplines is to give due recognition to other disciplines and strive for a 'holistic' policy.

5. My fifth suggestion is to find out the decision-making process, not as it may be written down somewhere, but as it actually exists. In my experience,

the decision-making process is fluid and changes depending upon the issue being discussed. To ensure that this fluid decision-making process does not negatively affect whatever I am dealing with, I get other groups 'on side' by dealing with my counterparts in other agencies for as long as it takes to reach a consensus. They then have the obligation to convince their superiors, etc., so that when the issue gets to the decision table the chances are enhanced that what is being recommended will be accepted. This approach also ensures commitment on everyone's part to implement the accepted policy.

The most unhealthy event for an official's well-thought-out rational policy proposal is to have an Exocet missile fired at it during a cabinet committee meeting. These missiles come in very low, very fast and destroy their target, not because they are well aimed, but because they are fired in anger by an agency which has not been neutralized by prior discussion.

These suggestions, if deemed by the 'specialists' to be of sufficient value and acted on, will close the gap and lead to improved and stable mineral policies. If not, then the gap will, as I have hypothesized, widen.

PROVIDING POLICY ADVICE TO CENTRAL PLANNING AGENCIES: A FEDERAL VIEWPOINT

By David E. Bond[1]

Establishing Policies and Priorities: Allocations between Sectors

Establishment of policies and priorities is a complicated and sequential process, involving flows of requests and information horizontally between departments, and vertically through departments, central agencies and cabinet subcommittees to the cabinet. Using the Ministry of State for Economic Development (now Economic and Regional Development) as an example of a central agency, the process is as follows.

1. About November, a letter is sent from the Minister of State for Economic Development to the other departments whose ministers are on the Cabinet Committee on Economic Development, requesting their help in developing priorities for the following five years.

   At the same time, the department of Economic Development produces and circulates a document called the 'Medium-term Track', which is a forecast of what the economy is expected to look like for the next five years. This document usually has one or two additional themes as well. Last year, for example, it looked at whether or not there has been a shift of Canadian trade away from manufactured goods and towards basic commodity groups, and what are the implications.

2. Each department involved in economic development then looks at its own current activities and its priorities for the next five years, and at the policies that will be needed to deal with its objectives. (The five-year span exists in theory, but in practice the attention of departments tends to be directed ahead only as far as the current mandate of the government, since the ultimate objective is achieve or retain political power.) The minister, or in fact one of his bureaucrats, drafts an overview in the form of a letter to the Minister of State for Economic Development, trying to tie in the department's objectives with those in the minister's November letter. There is some evidence of a lack of broad overview within departments at this stage of the process. For example, a proposal to expand production and sales of commodities may be made without regard for transportation facilities.

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1. This text was prepared by CRS staff from a tape of Dr. Bond's address to the seminar.

3. Economic Development then assesses the departmental overviews, looking at the principal thrust of each, at the costs in dollars and person years, at jurisdictional questions etc., all in the context of the November letter. The assessment process also identifies messages or initiatives that should be brought before the entire cabinet.

4. Detailed discussions are held with each department, to ensure complete understanding of their views, and to explain the cost implications and the impact of the department's objectives on the overall priorities. Some level of agreement or consensus on approaches is reached.

5. The Department of Economic Development next prepares an 'Overview of Overviews', which is a memorandum written by bureaucrats and sent in the name of the minister to each of his cabinet colleagues.

   This document acknowledges each colleague's overview document and the subsequent discussions, and supports the approaches that have been agreed upon. It also sets out the following:

   - the basic economic setting;
   - the department proposals that agree with and those that diverge from the general policy thrust that has been articulated by the government in the past;
   - the priorities that have been identified in the course of the process;
   - areas of concern;
   - the financial implications.

6. This document is then sent to the Cabinet Committee on Economic Development for discussion. The committee selects the major priorities, and sets them out along with justification and estimation of the costs. This determines what is called the Economic Development Envelope.[2]

7. The resulting document is then sent to the Cabinet Committee on Policy and Priorities, also called the 'inner cabinet', along with similar 'envelope' documents from committees for the other sectors, such as social, external, science and technology, defence etc. This committee decides on the allocation of all the funds that are available to the finance minister through taxes, borrowing, or other sources. It establishes priorities among the sectors, and uses these priorities to allocate funds to each for a five-year period.

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2. This process is clearly described in G. Bruce Doern, ed., How Canada Spends Your Tax Dollar.

Allocation of Funds Within Sectors

Once this five-year allocation between sectors is made, departments must seek funding for their own programs from their respective envelopes. The process is as follows.

1. Various bureaucrats within departments perceive or are asked to consider problems, or changes in the environment, or opportunities. They analyze these matters, and look for options to deal with them. The result is two documents: a discussion document, for example EMR's Mineral Policy: A Discussion Paper; and a memorandum to cabinet.

2. Discussion document: this is prepared by the department initiating a request for funding of new policies or programs. It includes a detailed discussion of the perceived problem or opportunity, and looks at alternative ways of approaching it. The alternatives must be real and viable, and not 'straw men', if trust and credibility are to be maintained. The discussion paper is circulated to departments with related interests. It goes always to finance, and to others as well for discussions, changes and compromises until some degree of consensus has been achieved, and it is clear that the implications of the alternatives for other sectors have been anticipated and understood.

3. The memorandum to cabinet is prepared by the initiating department, on the basis of the discussion paper and the subsequent compromises. The memorandum sets out the problem or the opportunity, some background information, two or three options, methods of implementation, and a check list of related or affected issues (e.g. federal-provincial relations, external relations, women, environment, communications strategy etc.) Finally the memorandum should recommend one option, and support the recommendation. Ideally, all of this should be done in four pages, but it never is that short.

4. Both documents are sent through the central agency to its cabinet committee, in this case the Economic Development Committee.

5. On Thursdays all the deputy ministers get together to discuss the papers that are going to the cabinet the following Tuesday. This discussion serves among other things to brief and prepare the department, because it indicates to the initiating deputy minister the kinds of reactions and advice that will be passed on by the other deputy ministers and their staffs to their ministers. If consensus was obtained at stage 2 of the process, there will likely be few problems at this later stage. If consensus has not been obtained, and there is opposition, the proposal will be sent back for revision.

6. The memorandum and discussion paper go to the cabinet for consideration. By this time all opposition should have been eliminated. If this is so, and cabinet endorsement or approval-in-principal is received, then the department must prepare proposals for implementation, through in-house and possibly public discussions and study. For example, once the cabinet endorsed the basic thrust of the Mineral Policy: A Discussion Paper, Mrs. Erola was asked to discuss implementation of the proposals with the private sector.

7. Documentation presented to the cabinet tends to very voluminous, and very few ministers are able to read all of it. For this reason they rely heavily on the assessment notes prepared for them by the department. These notes should provide a neutral assessment of the proposed program, including all anticipated effects. They should be as brief and as factual as possible, and designed to let the ministers make up their own minds, rather than to persuade or influence them. (Ministers are very sensitive to suggestions that bureaucrats make policy decisions.) Acceptance of the findings of assessment reports can occur only if trust has been developed between the ministers and those providing the assessments.

Closing Comments

The process seems very complex, with a great deal of paperwork, cross communication, and delay. However, policy issues are very complex, and require careful analysis of their impacts on the overall equilibrium. For example, a new agricultural policy could affect transportation, or the environment, or the balance of payments. The process provides opportunities to identify all the aspects and anticipate all the consequences.

The basic principal in policy-making in cabinet government is consensus among the cabinet colleagues. However, in addition to government participants in this process, there are also very articulate and influential groups across the country. Cabinet ministers have to take their views or potential objections into account, and avoid proposing policies that will evoke violent opposition from the public. A bureaucrat who ignores or overlooks such a possibility when advising his minister may not be fired as a result, but he certainly can be sidetracked and have his career eclipsed.

Mineral policy, as with any other policy, must be established by following the processes described above, going through all the levels and departments, interdepartmental bodies, and central agencies. The importance ascribed to it by the players in the process will vary according to the impact of the policy on their own sectors and on competing or complementary policies, and according to the

economic, social, and political circumstances of the time. Mineral policy is not generally a high priority area, and presumably comes to the fore only when it is wanted or needed to resolve a particular problem or realize a specific opportunity.

REGIONAL MINERAL RESOURCE ASSESSMENT

by

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Summary

This paper discusses some basic principles of regional mineral resource assessment and gives Canadian examples (case histories) and applications.

The two broad categories of assessment are qualitative and quantitative. In practice, many assessments are a mixture of the two. Geological assessments estimate the probability of the existence of undiscovered resources. Other analyses (economic, technological, political, etc) may then be added to estimate the likelihood of development or exploitation of resources, assuming their existence and discovery. Methods of (geological) assessment vary; in principle however, they are all based at source on mineral deposit models, either implicit or explicit. 'Relative' assessments yield judgements of the potential for the existence of (undiscovered) mineral deposits of particular types in subdivisions of the assessment region (areas, domains, cells) relative to other subdivisions of the same region. 'Absolute' assessments yield judgments of the potential for particular mineral deposit types to exist that are independent of potential ratings assigned for other subdivisions in the same assessment region.

About 30 past Canadian projects provide examples of most assessment types and applications. Three examples are described briefly that illustrate:

i quantitative estimates on a national scale (Operation September);
ii geological (qualitative) assessments on a provincial scale (NREP);
iii qualitative assessments on various scales for specific land-use purposes (Northern Canada studies).

Resource assessments form part of the information base in mineral policy and planning processes. They also have a variety of uses in land use planning and policy. To date, however, one of the difficulties has been to develop effective and systematic procedures to incorporate the results of resource assessments in such policy and planning processes.

Introduction

The terms of reference given by the organizers of this symposium included a number of suggested topics under the heading of 'Regional Mineral Resource Assessment.' Paraphrased as questions, they were:

i who are the customers and clients (for resource assessments)?
ii what are the data bases and methods used in resource assessments and what are relevant Canadian applications to date?
iii how are long-term research priorities needed to provide the underpinnings for good resource assessments preserved, in the face of pressures for short-term 'quick' results for use in policy and planning processes?
iv what is the input of resource assessment in policy analysis (current and future)?

The questions are ranked here in ascending order of difficulty. For government agencies involved in resource assessment, the customers and clients are reasonably well identified (see figure 1). The answers to question two are largely technical and are the main focus of this paper. Question three presents problems to managers in organizations that are essentially long-term research oriented. Question four is difficult. It sometimes appears that the answer to four is 'none', but this is probably unduly pessimistic; useful mechanisms should evolve with time and experience. Based on experience to date, one of the most difficult aspects of resource assessment is how to incorporate the results effectively into planning and policy processes.

This paper examines some of the principles and components of regional mineral resource assessment. For convenience it is useful to consider the topic in three main categories:

i basic principles;
ii case histories;
iii applications (current and future).

Basic Principles

Definitions

Regional Mineral Resource Assessment

There are two broad categories of resource assessments. One type provides estimates or 'prognostications' of the kinds and amounts of mineral resources re-

MINERAL RESOURCE ASSESSMENT

SOME ANSWERS

1. CUSTOMERS

GOVERNMENT AGENCIES (FED. & PROV.)
ENVIRONMENTAL PANELS ETC.
LAND USE PLANNERS
CONSULTANTS
NATIVE PEOPLES' ORGANIZATIONS
MINERAL INDUSTRY

2. (A) DATA; (B) METHODS; (C) CASE HISTORIES

(A) GEOLOGICAL, GEOCHEMICAL, GEOPHYSICAL: COMPUTER-GENERATED MINERAL DEPOSIT DATA · EXPLORATION HISTORY RECORDS
(B) COMPLEX SUBJECTIVE · MULTIVARIATE GEOSTATISTICAL ANALYSIS
(C) ABOUT 30 DOCUMENTED CANADIAN STUDIES SINCE 1960 : ABOUT A DOZEN G.S.C. PROJECTS SINCE THE MID-1970s

3. RESEARCH PRIORITIES

SOLUTIONS EVOLVE WITH PRACTICAL EXPERIENCE : FEEDBACK LOOPS BETWEEN R.A. PRODUCTS AND NEW RESEARCH . R.A. IS PART OF REGIONAL METALLOGENIC RESEARCH

4. POLICY INPUT

NEEDED ARE MECHANISMS TO ENSURE R.A. PRODUCTS ARE INCORPORATED IN DECISION PROCESSES (E.G. NORTHERN LAND-USE PLANNING)

Figure 1. Clients and customers, data and methods, research priorities and policy input in regional mineral resource assessment.

The 'Resources' in Resource Assessment

For the present purposes, complex technical definitions of the various categories of reserves and resources are not necessary. However, some basic distinctions are needed. Figure 2 is a greatly simplified version of the 'McKelvey Box' (McKelvey, 1973). Resource assessments are concerned with both sides of figure 2, but in different contexts. The left side (known resources) provides input data on known mineral deposits containing economic and/or subeconomic resources. The right side is output from the assessment process, in the form of predictions of the kinds, locations and amounts of undiscovered resources.

The distinction between fields A (undiscovered 'reserves') and B (undiscovered 'subeconomic resources') on the right side is not possible in absolute terms. It is, however, feasible during the assessment process to incorporate qualitative judgments concerning the probability of undiscovered resources belonging in either of fields A or B. In part the information on which such judgments are made comes from the left side of figure 2 (e.g. typical grade and tonnage characteristics of known deposits), and in part it comes from additional analyses.

Methods in Resource Assessment

A variety of methods have been developed in resource assessment. Figure 3 lists six general categories of assessment types, along with the kinds of applications they are appropriate for. Note that the first three categories of figure 3 are most suitable for quantitative estimates of very large regions or for national resource estimates. The last two on the list are the ones we are mainly concerned with here. The last one is now commonly referred to as 'complex subjective' but the concept of 'relativity' remains important (see later).

Certain assessments are concerned only with geological prognostications of the existence of resources, without qualifications as to the probability of exploitation or development of the resources, assuming they are discovered. Other types of assessments may carry the prognostication process further, and add economic and technological ('mineability') assessments to the geological assessment base. In figure 4, these two processes (geological assessment, economic assessment) have been arbitrarily separated for illustrative purposes.

In practice, Process A (geological assessment) contains elements of Process B, by virtue of the choice of mineral deposit models used (some deposit types are,

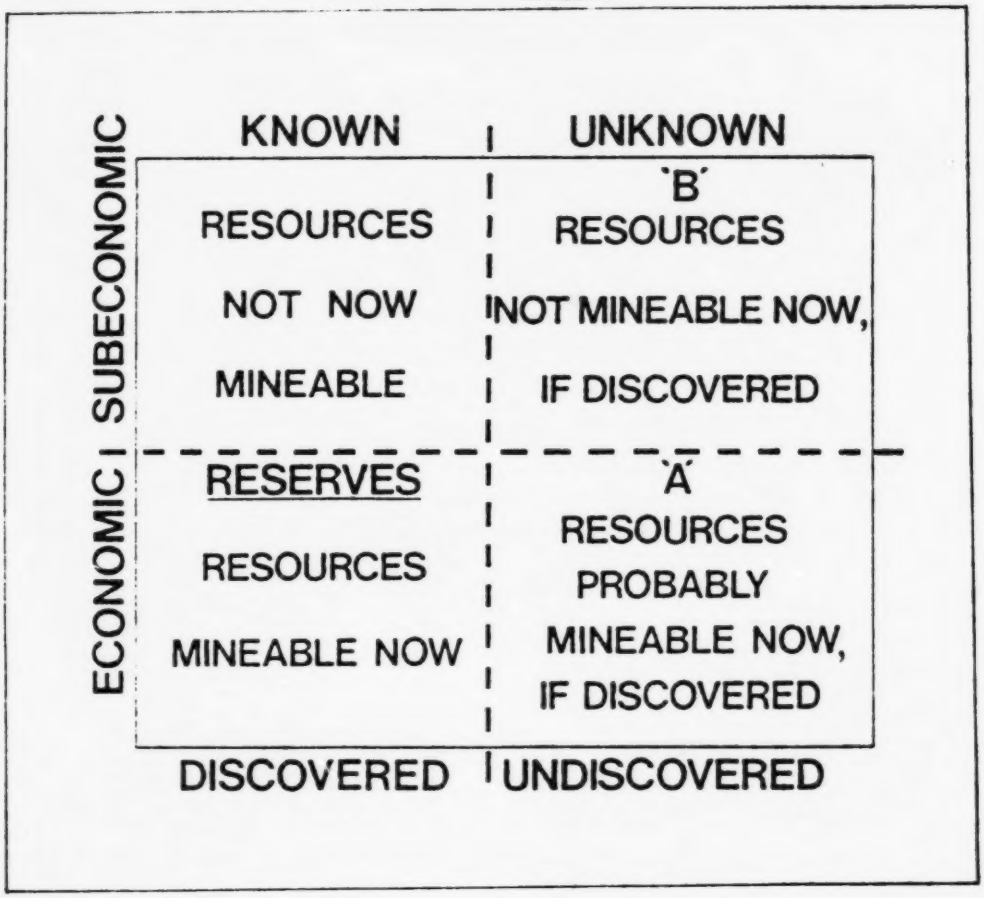

Figure 2. Basic categories of resources. Resource assessments make use of information in the left-hand fields (known/discovered resources) in the derivation of estimates in the right-hand fields (unknown/discovered).

ASSESSMENT METHOD	PRODUCT TYPE	APPLICATIONS
"LIFE CYCLE"	QUANTITATIVE	ESTAB. DISTRICTS/ PLAYS "HARD" DATA
UNIT VALUE (VOLOMETRIC, AREAL)	QUANTITATIVE ($)	LARGE REGIONS AGGREGATED RESULTS
CRUSTAL ABUNDANCE	QUANTITATIVE	"ULTIMATE" RESOURCES COARSE ESTIMATES
SUBJECTIVE PROBABILITY ("DELPHI" ETC.)	QUANTITATIVE & QUALITATIVE	VARIOUS MODIFICATIONS CURRENT OIL & GAS (IN PART)
MULTIVARIATE GEOSTATISTICAL ANALYSIS	QUANTITATIVE (PROBABILITY)	REGIONAL ANALYSES
SUBJECTIVE RELATIVE POTENTIAL	QUALITATIVE	REGIONAL & LOCAL

Figure 3. General categories of resource assessment methods. The last two categories (multivariate geostatistical analysis and subjective relative potential) are the ones of principal concern in this paper.

by definition, 'more economic' than others). Conversely, Process B (economic assessment) must have, of course, a geological assessment incorporated in its base.

Quantitative and Qualitative Assessments

As noted earlier, certain types of assessment methods are described as qualitative; others as quantitative (see figure 3). In reality most assessment processes (except those depending on pure operations research or spatial analysis methods) have some subjective, qualitative component, although the bulk of the operations performed may be quantitative (e.g. various types of parameter or characteristic analysis) and the output or product may be expressed in quantitative terms (e.g. probability estimates of tonnes of metal). Somewhere in the method, however, is a transformation process involving the human (subjective) element. This may commonly occur early in the process when geological features are (subjectively) selected and coded for machine-processing.

With the above reservations in mind, most assessment processes need to be categorized according to the nature (qualitative or quantitative) of both the input and output sides. Figure 5 illustrates the various combinations possible. Without going into details, the Geological Survey has been mainly concerned with Type 1 (qualitative to qualitative) for minerals and Type 3 (quantitative to quantitative) for oil and gas. For reasons discussed later, our feeling is that Type 4 (quantitative to qualitative) assessments are likely to evolve as the most useful general product in many applications, including applications by industry.

Mineral Deposit Model Analogues

Most mineral resource assessment processes are based on the application of composite models of particular types of mineral deposits and their geological settings that have been constructed from world-wide data bases. Such composite models provide the 'controls' against which the geological characteristics of an area or environment being assessed are tested against. Figure 6 (after Large, 1980) for example shows the composite geological-tectonic model for the setting of stratiform submarine exhalative barite massive sulphide deposits, from which a significant portion of the world's supply of lead and zinc is recovered. Canadian representatives of this class include the Sullivan Mine (Kimberley, B.C.), the Anvil (Faro) deposits of Yukon and the Howard's Pass deposit of the

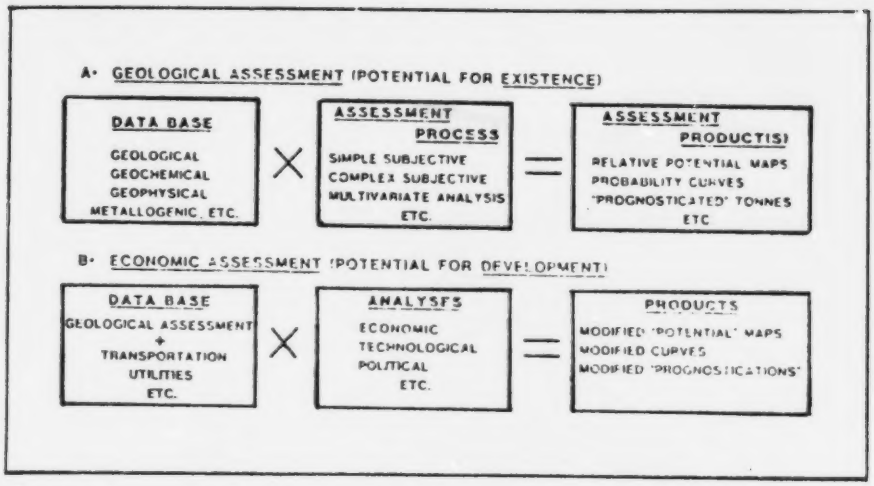

Figure 4. The distinction between the assessment of the potential for existence of resources and the assessment of the potential for development or exploitation.

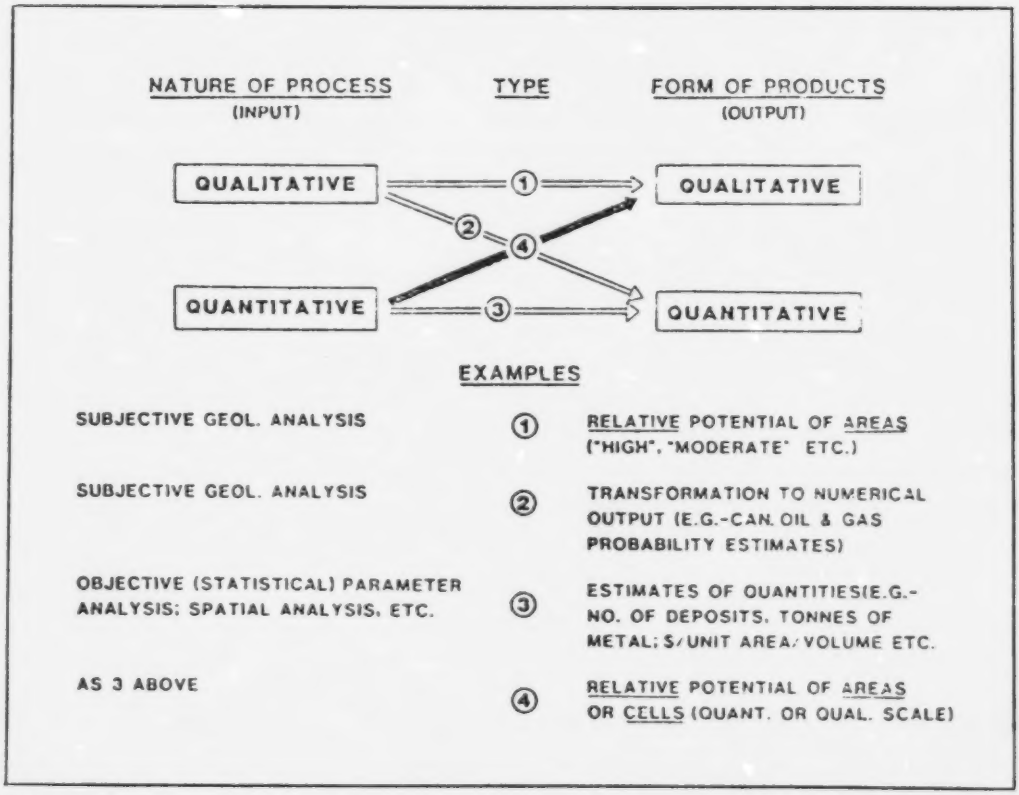

Figure 5. Types of Resource Assessments. Different types of resource assessment may result from different mixes of input methods (operations) and output formats. Type 4 (black arrow) using quantitative methods to derive qualitative (relative value) output seems a logical route for many future projects.

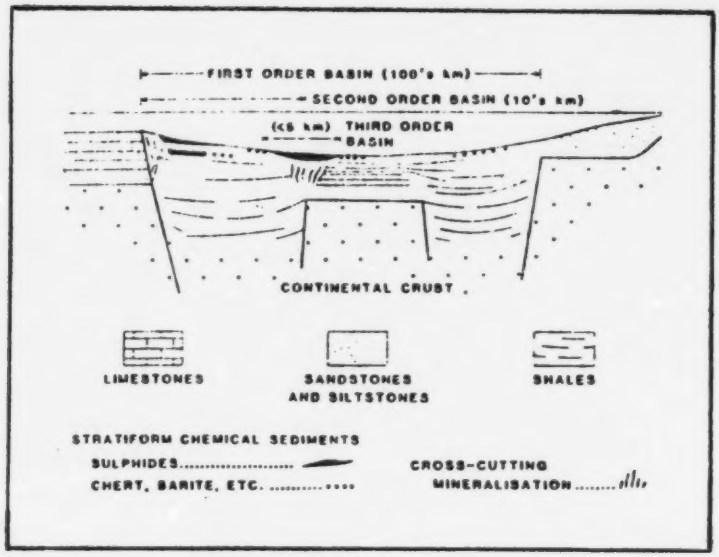

Figure 6. Regional setting of (composite) sediment-hosted submarine exhalative massive suphide deposit (from Findlay and Sangster, 1982, modified from Large, 1980).

northern Mackenzie Mountains, on the Yukon-NWT border. Figure 7 (from Findlay et al., 1981) illustrates the application of an earlier version of this model (Krebs, 1979) to the North Baffin Rift Zone (Borden Basin) of northwest Baffin Island. In this example, it was concluded that many of the attributes or 'metallotects' required by the Krebs-Large model for stratiform massive sulphide deposits were present, at least to the second order level, in Borden Basin.

The Principle of 'Relativity'

In most cases the yardsticks of assessment are relative. Less commonly, they may be 'absolute'. Two cases may be considered as illustrations. In the first (figure 8.1) the mineral potential assigned to domain 1 A in assessment area XY

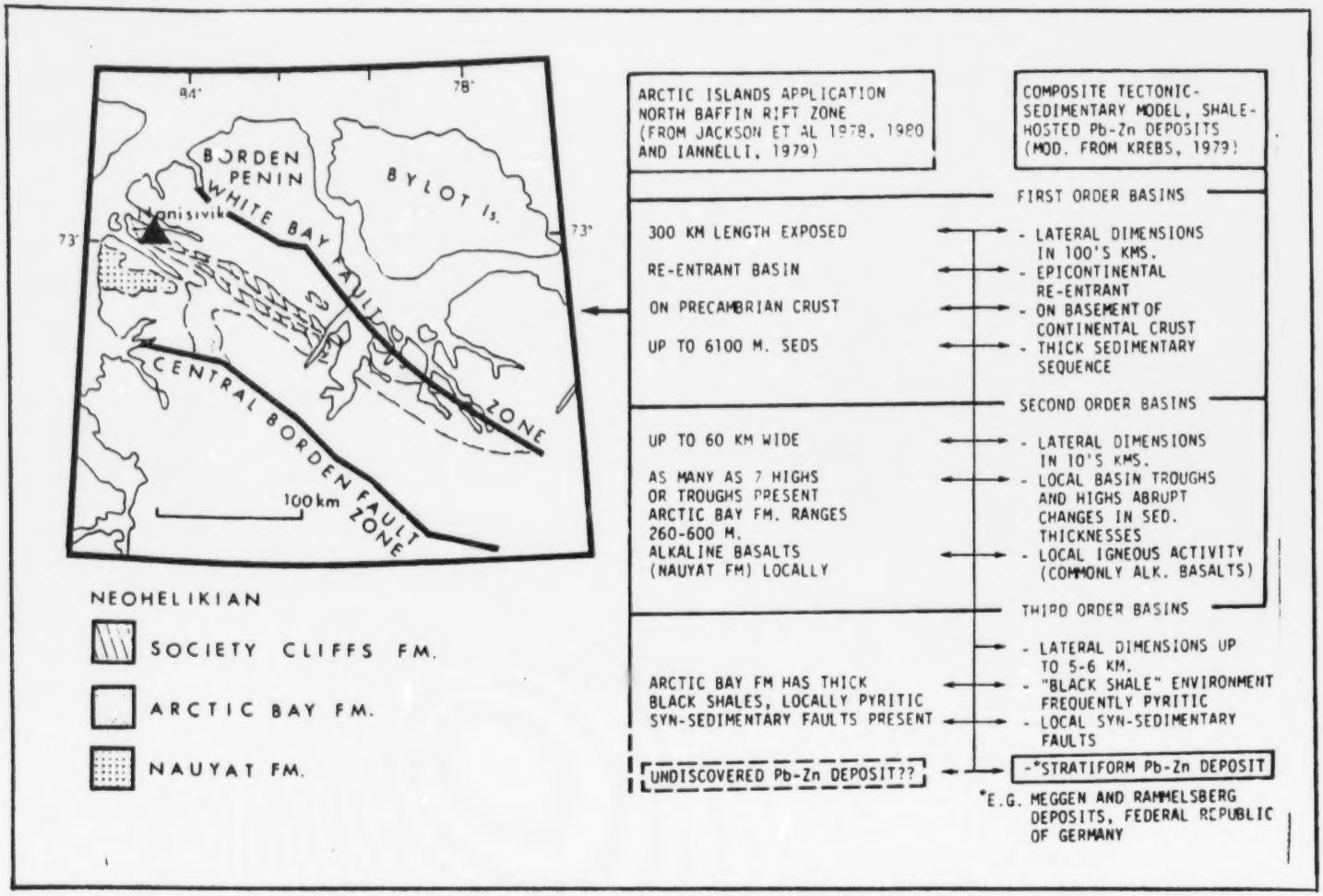
94°
78°
73°
73°
BORDEN PENIN
BYLOT Is.
Nanisivik
WHITE BAY FAULT ZONE
CENTRAL BORDEN FAULT ZONE
100 km
NEOHELIKIAN
SOCIETY CLIFFS FM.
ARCTIC BAY FM.
NAUYAT FM.
ARCTIC ISLANDS APPLICATION
NORTH BAFFIN RIFT ZONE
(FROM JACKSON ET AL 1978, 1980 AND IANNELLI, 1979)
COMPOSITE TECTONIC-SEDIMENTARY MODEL, SHALE-HOSTED Pb-Zn DEPOSITS
(MOD. FROM KREBS, 1979)
FIRST ORDER BASINS
300 KM LENGTH EXPOSED
- LATERAL DIMENSIONS IN 100'S KMS.
RE-ENTRANT BASIN
- EPICONTINENTAL RE-ENTRANT
ON PRECAMBRIAN CRUST
- ON BASEMENT OF CONTINENTAL CRUST
UP TO 6100 M. SEDS
- THICK SEDIMENTARY SEQUENCE
SECOND ORDER BASINS
UP TO 60 KM WIDE
- LATERAL DIMENSIONS IN 10'S KMS.
AS MANY AS 7 HIGHS OR TROUGHS PRESENT ARCTIC BAY FM. RANGES 260-600 M.
- LOCAL BASIN TROUGHS AND HIGHS ABRUPT CHANGES IN SED. THICKNESSES
ALKALINE BASALTS (NAUYAT FM) LOCALLY
- LOCAL IGNEOUS ACTIVITY (COMMONLY ALK. BASALTS)
THIRD ORDER BASINS
- LATERAL DIMENSIONS UP TO 5-6 KM.
ARCTIC BAY FM HAS THICK BLACK SHALES, LOCALLY PYRITIC
- "BLACK SHALE" ENVIRONMENT FREQUENTLY PYRITIC
SYN-SEDIMENTARY FAULTS PRESENT
- LOCAL SYN-SEDIMENTARY FAULTS
UNDISCOVERED Pb-Zn DEPOSIT??
-*STRATIFORM Pb-Zn DEPOSIT
*E.G. MEGGEN AND RAMMELSBERG DEPOSITS, FEDERAL REPUBLIC OF GERMANY

Figure 7. Comparison of the geological environments of the North Baffin Rift Zone, northwestern Baffin Island (Borden Basin) with those of the general sediment hosted exhalative massive sulphide deposit of Figure 6 (from Findlay et al., 1981).

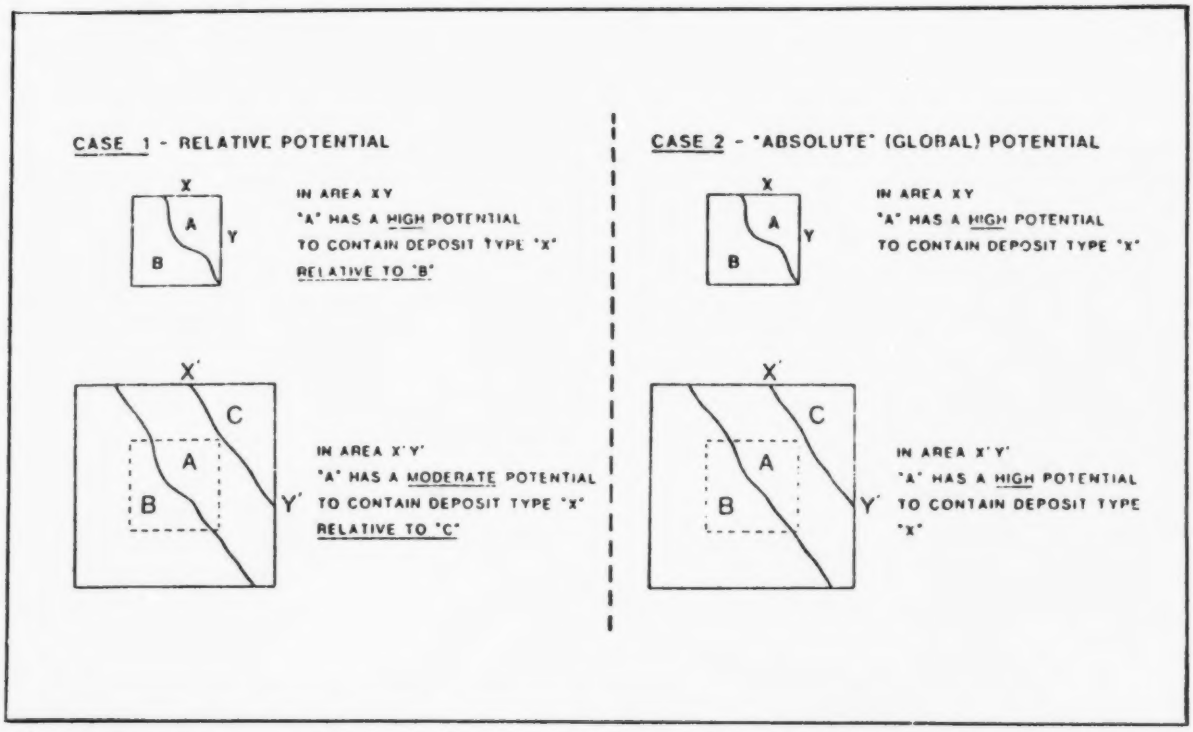

Figure 8. Two cases illustrating the difference between 'relative' potential and 'absolute' (global) potential. In Case 1 (left) the potential rating assigned to domain 'A' is dependent on the size of the study area (XY and X'Y'). In Case 2 (right) the potential rating assigned to domain 'A' is independent of the study area and rests on the presence or absence of 'absolute' or global attributes for the particular mineral deposit model being considered.

(top) may change when area A is considered as part of the larger assessment area X'Y' (bottom).[1]

In this case the potential for an assessment domain (e.g. A) to contain one or more deposits of type X is considered relative to the potential of other domains within the boundaries of the assessed area.

In the second case (figure 8.2) ratings are assigned on the basis of the attributes (metallotects) demanded by the global model for deposit-type X. In practice we have found that the Case 1 application (figure 8.1) is by far the most commonly used. The reasons for this are related mainly to:

i deficiencies in the model(s);
ii deficiencies in the data base available for the area under assessment.

Case Histories

A list of Canadian resource assessment studies of various types, extending back to the late 1950s-early 1960s is given in figure 9. A number of sample projects selected from the list to illustrate different types and stages of Canadian resource assessment work in more detail is shown in figure 10. The first ('Operation September') is an example of a quantitative assessment on a national scale. The second (NREP) illustrates the application of geological assessment (qualitative) techniques on a large regional (province-wide) scale. The third is a group of recent, mainly qualitative assessments conducted in northern Canada for specific purposes involving land use questions.

Operation September

This project was carried out by the Department of Energy, Mines and Resources in 1972 to provide estimates of reserves and additional resources (known and undiscovered) of copper, lead, zinc, nickel, molybdenum, uranium and iron ore by geological region (province) and by totals for Canada.

The original (1972) estimates were updated and modified in 1976. Results were published in two EMR reports in 1977 (EMR 1977a, 1977b).

1. A 'domain' is a subdivision of an assessment area that is characterized by continuity of geological characteristics (stratigraphy, age, lithologies, etc).

IDENT.	YEAR	AUTHORS	AREA	COMMODITIES REPORTED	METHOD	FORM OF RESULTS
1	1958	Lang (GSC)	Canada	Uranium	Geological	Qualitative
2	1966	Roscoe (GSC)	Canada	Uranium, Thorium	Geological	Qualitative
3	1967	Gross (GSC)	Canada	Iron	Geological	Qualitative
4	1969	Kelly & Sheriff	B.C.	Various	Geostatistical	Quantitative
5	1970	Harry & Freyman	Northern B.C. & Yukon	Various	Subjective Prob. (Delphi)	Quantitative
6	1971	Degeoffrey & WU	Cdn. Shield	Various (Dollar Values)	Probabilistic	Quantitative
7		Degeoffrey & Wignal	Grenville Prov. (part of)	Various (Dollar Values)	Probabilistic	Quantitative
8	1972	Agterberg et. al. (GSC)	Abitibi Dist.	Copper, Zinc	Geostatistical (Multivariate Anal.)	Quantitative
9	1972	Azis et. al.	N. Manitoba	Various	Subjective Prob. (Delphi)	Quantitative
10	1972	E.M.R.	Canada (Operation Sept.)	Cu, Pb, Zn, Mo, Ni, U, Fe	Geological	Quantitative
11	1973	Derry	Arctic & Sub Arctic	Cu, Pb, Zn, Au, Fe	Geological	Quantitative
12	1973-74	McCartney	B.C.	Various	Geol. Probability	Qualitative
13	1974-75	(GSC)	Appalachians	Various	Geostatistical	Quantitative
14	1977	Ont. Dept. Mines & E.M.R.	Ontario	Zinc	Subjective Probability	Quantitative
15	1977	E.M.R.	Canada	Cu, Pb, Zn, Mo, Ni, Fe	Geological	Quantitative
16	1975-80	E.M.R.	Canada	Uranium	Geological/ Geostatistical	Quantitative
17	1975-80	Man. Div. of Mineral Resources (E.M.R.)	Manitoba	Cu, Zn, Ni	Geological	Qualitative
18	1977	GSC (of 492)	Western Arctic	Various	Geological	Qualitative
19	1978	GSC (of 691)	N. Yukon & NWT (parts of)	Various	Geological	Qualitative
20	1978	Agterberg & Divi (GSC)	Appalachians	Cu, Pb, Zn	Geostatistical	Quantitative
21	1980	GSC (of 716)	N. Yukon, NWT (parts of) & Arctic Islands	Various	Geological	Qualitative
22	1981	Findlay et. al. (GSC)	Arctic Islands	Various	Geological	Qualitative
23	1981	Agterberg et. al. GSC (of 718)	S. District of Keewatin, NWT	Various	Geostatistical	Quantitative
24	1981	GSC (of 760)	N. Yukon	Various	Geological	Qualitative
25	1981	GSC (of 786)	N. Ellesmere Is.	Various	Geological	Qualitative
26	1982	Sinclair et. al. (GSC in Prep)	Yukon	Various	Geological	Qualitative

Figure 9. Selected examples of Canadian resource assessment studies, 1958 to 1981 (from Findlay and Sangster, 1982).

YEAR	NAME	AREA	METHOD(S) OR PRODUCT	COMMODITIES	CLIENT	REF.
1972 1976	"OPERATION SEPTEMBER" "OP SEPT UPDATE"	CANADA	QUANT	Cu, Pb, Zn, Ni U, Mo, Fe ORE	FED GOVT (EMR)	EMR, 1977
1975-80	NREP (NON-RENEWABLE RESOURCE EVALUATION PROGRAM)	MANITOBA	QUAL	Cu-Zn, Ni, Cu-Ni, Cu	FED GOVT MAN GOVT INDUSTRY	GALE ET AL., 1980 THEYER, 1980 PINSENT, 1980 BALDWIN, 1980 BAMBURAK, 1980 ETC
1977-82	G S C NORTHERN CANADA ASSESSMENTS (9 PROJECTS TO DATE)	ARCTIC ISLANDS MAINLAND N W T YUKON	QUALT (+QUANT)	VARIOUS, INCLUDING COAL, OIL & GAS	DIAND (O N C.) PARKS CANADA I T C. INDUSTRY	G S C OPEN FILE REPTS 492, 691, 716, 718, 760, 785 ETC

Figure 10. Selected Canadian resource assessment projects to illustrate:
i quantitative assessment on a national scale (Operation September);
ii geological assessments on a province-wide (Manitoba) scale; and
iii assessments conducted at various scales (1:250,000 to 1:300,000) in northern Canada.

The Operation September data represented probably the first serious consolidated estimates of Canada's resources of major trade minerals. National estimates for uranium and for iron ore had been provided in previous studies but Operation September applied rigorous new guidelines for establishing quantities of materials in various categories of reserves, subeconomic resources and undiscovered resources.

NREP

The Non-Renewable Resource Evaluation Project (NREP) was a prototype four-year $1.6-million joint federal-provincial program in Manitoba. It was designed to provide evaluation of the potential for various parts of the province to contain additional (undiscovered) deposits of Manitoba's major metals - copper, zinc, nickel - as well as to evaluate geological environments where additional types of deposits not yet known in Manitoba might be expected (e.g. prophyry copper, 'sedimentary' copper). The project resulted in the establishment of a comprehensive computerized mineral inventory file for the Precambrian shield area of Manitoba (Bamburak, 1980); an assessment of the massive sulphide deposit potential of the Shield area (Gale et al., 1980); descriptions and discussions of ultramafic rocks associated with nickel deposits in Manitoba (Theyer, 1980); an

evaluation and interpretation of the copper-nickel deposits of the Lynn Lake gabbro (Pinsent, 1980) and assessments of the potential for sedimentary copper and prophyry copper mineralization in specific Manitoba geological environments (Baldwin, 1980a, 1980b).

Particularly in the case of the massive sulphide deposit study (Gale et al., 1980), new methods of presenting qualitative assessments of geological environments using combined lithologic and stratigraphic characteristics ('litho-domain' maps) were applied.

Northern Canada Assessments

Figure 11 shows the distribution of a number of resource assessment studies carried out by the Geological Survey since about 1977. The nine projects shown here constitute, in total, an initial mineral and fuel potential assessment of about 80 percent of Canada north of the 60th parallel. The studies were conducted for three main reasons:

i in response to requests from Native Peoples' organizations for assessment of lands involved in native land claim negotiations with the federal government (Geological Survey of Canada, 1978; 1980b);

ii in response to requirements for mineral and fuel resource assessments of northern lands proposed for national park and other conservation purposes (Geological Survey of Canada, 1980a; 1981b);

iii in attempts to develop better methods in resource assessment and draw to the attention of the mineral industry areas of perceived exploration potential in Northern Canada (Agterberg et al., 1981; Findlay et al., 1981; Findlay and Sangster, 1982; Sangster, 1982; Sinclair et al., in press).

The northern studies have evolved from the earlier small scale (1:3,000,000) 'simple subjective' assessments to more comprehensive and detailed (1:250,000; 1:500,000; 1:1,000,000 scales) 'complex subjective' works. As an example of the current qualitative methods in use, figure 12 shows the distribution of some 64 individual assessment domains devised for a recently completed assessment of Yukon Territory (Sinclair et al., 1982).

Figure 13 shows the (qualitative) assessment ratings assigned to the 13 Yukon domains considered to have potential deposits. Of these 13 domains, five were considered as having a very high potential to contain undiscovered stratiform massive sulphide deposits in addition to those already known. Of the five preferred domains, two are not known to contain examples of this deposit type at present (Findlay and Sangster, 1982).

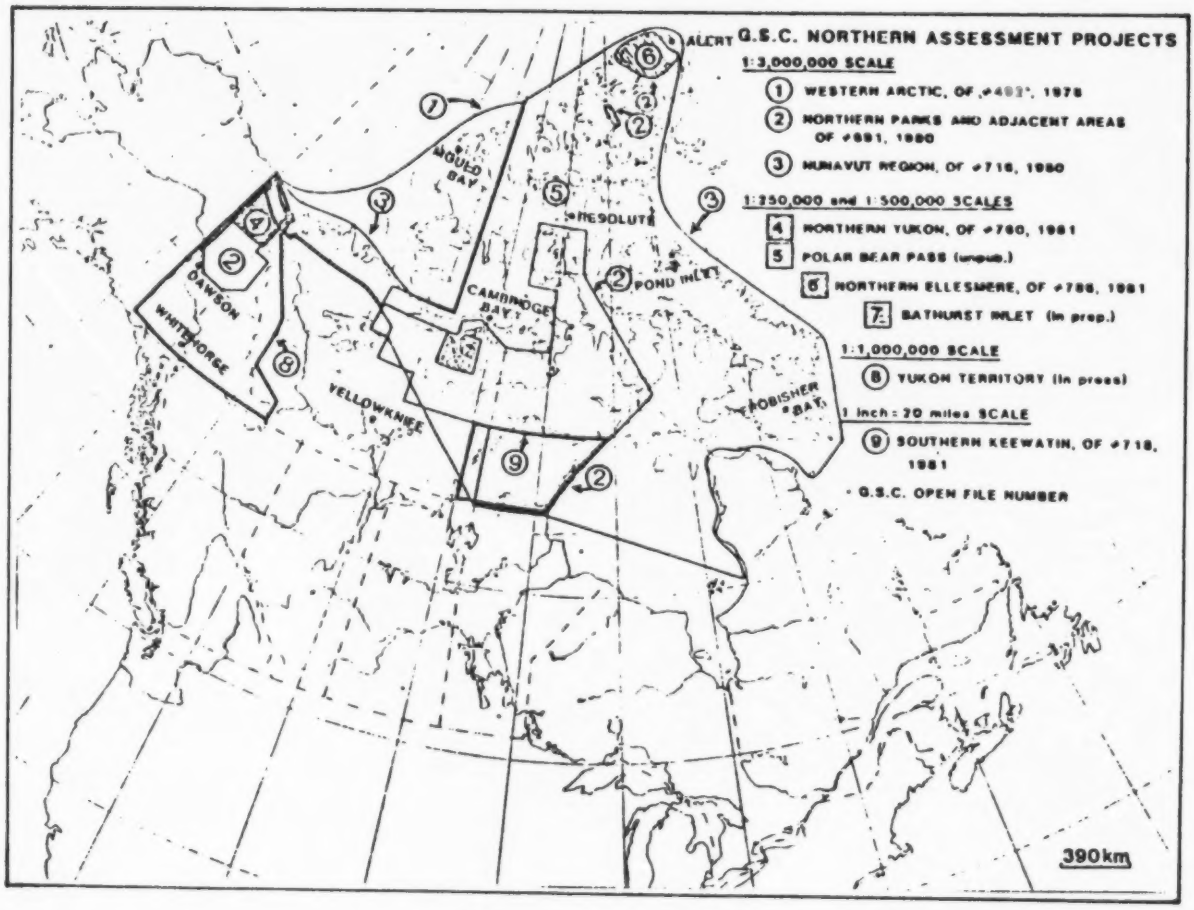

Figure 11. Recent (1977-1982) Geological Survey of Canada Resource assessment projects in northern Canada (from Findlay and Sangster, 1982).

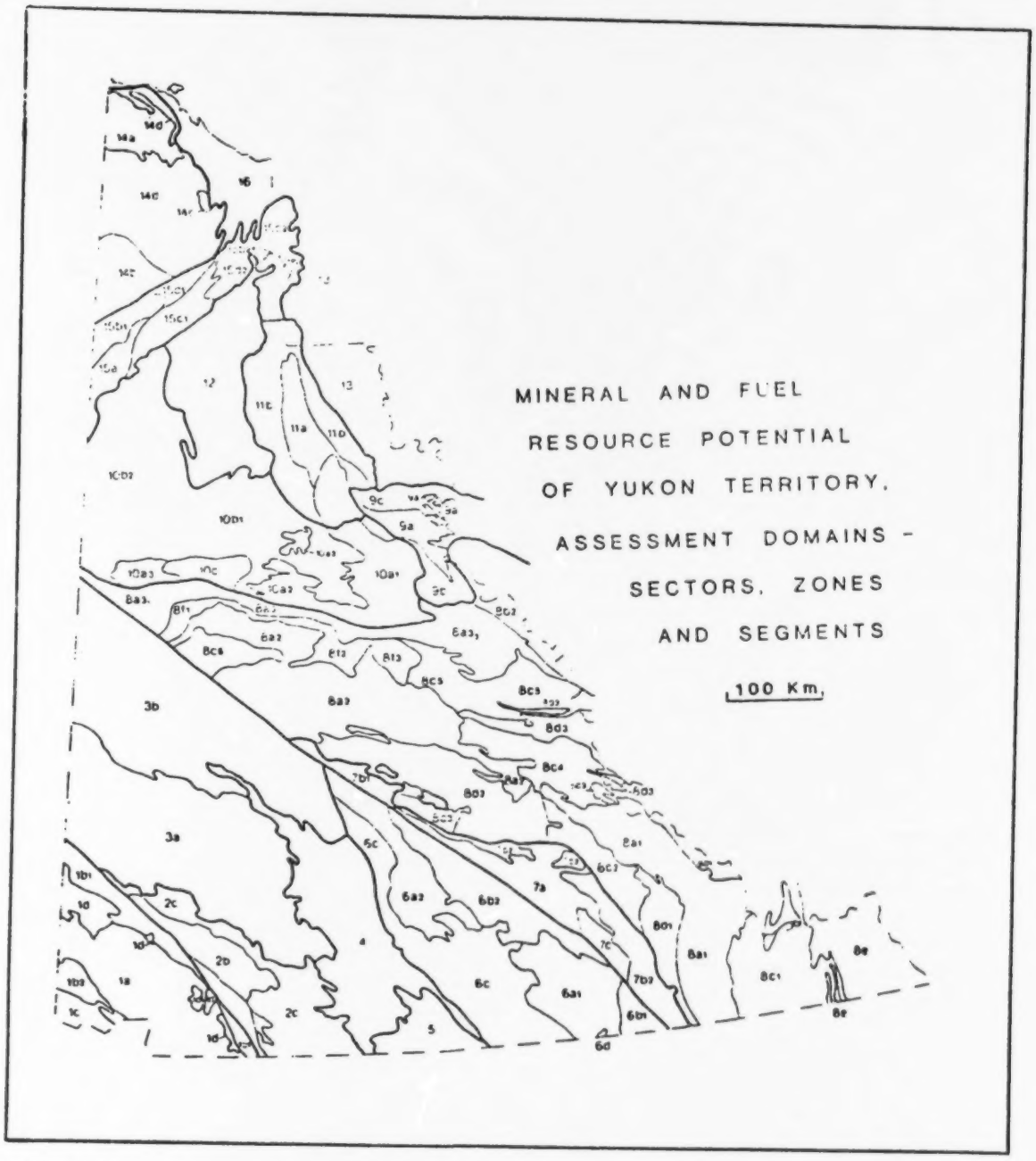

Figure 12. Assessment domains (64 in number) established for a recent GSC resource assessment study of Yukon Territory (project No. 8 of Figure 12).

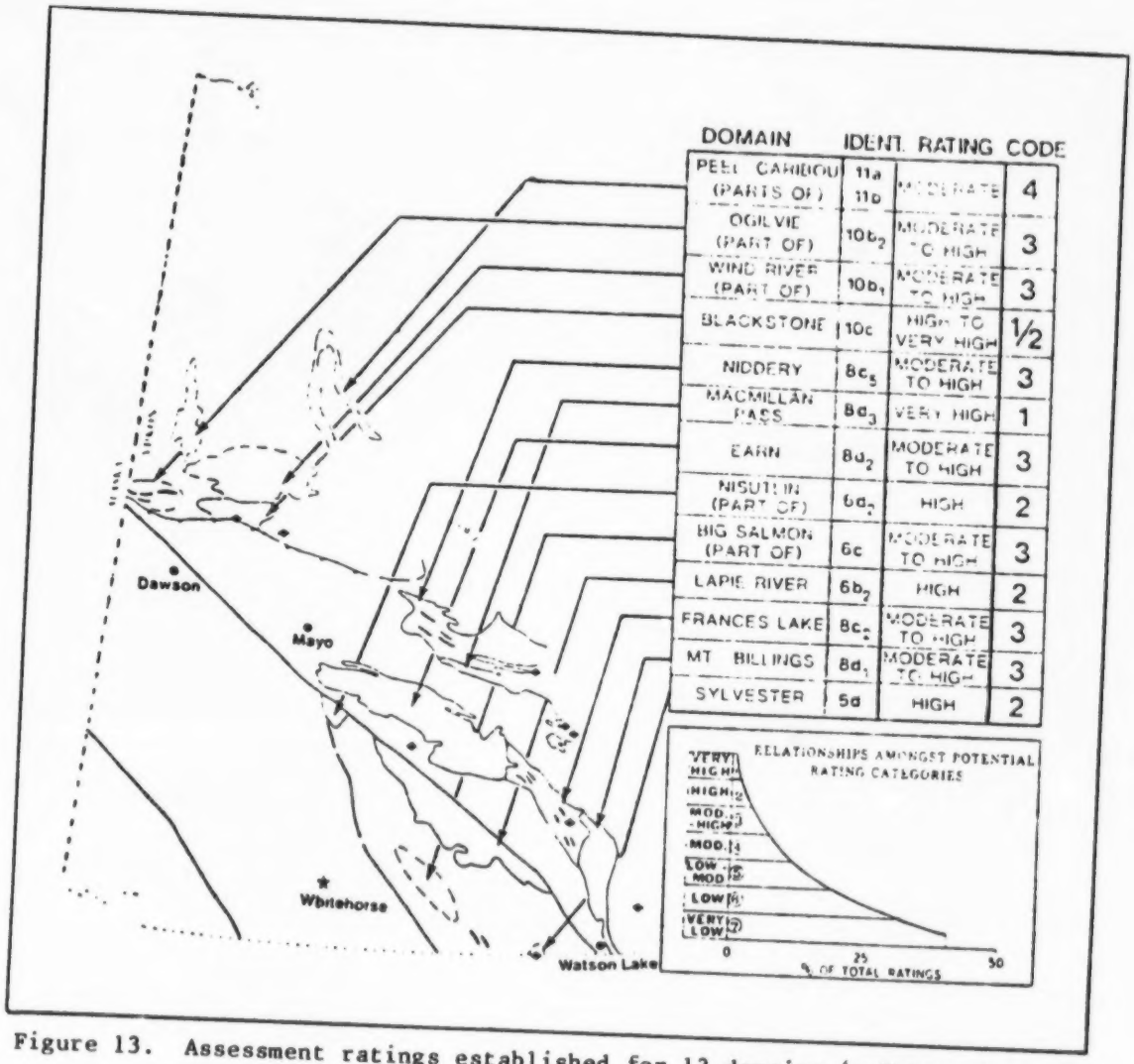

Figure 13. Assessment ratings established for 13 domains in Yukon study considered to have potential to contain stratiform massive sulphide-barite deposits in Devono-Mississippian 'Black Clastic' terranes (from Findlay and Sangster, 1982).

In contrast to the Yukon study, project no. 9 of figure 11 (Southern Keewatin) was an experimental assessment using quantitative techniques developed by F.P. Agterberg and his colleagues (Agterberg et al., 1981). Although the methods employed were quantitative (digitization of geological and gravity data, image analysis, multivariate statistical analysis) the end results were expressed in terms of the relative favourability of occurrence of specific types of mineral deposits among series of 10 km x 10 km cells assigned in the assessment area.

The Keewatin study is of particular interest because, as noted earlier, (see figure 5), assessment methods that proceed from quantitative input to qualitative output are useful in various land-use evaluation applications. The 'cells' in the Keewatin project are analogous in concept, although not in scale, to the 'domains' of the Yukon study. The use of rigorous internal statistical methods in an assessment process that rests on detailed knowledge of mineral deposit types and sound metallogenic concepts may be the ideal combination for this type of application.

Applications

Various procedures have long been established for incorporating oil, gas, coal and uranium resource estimates as background information against which policy and planning decisions have been made. With a few exceptions, similar procedures have generally not been developed on the mineral side. In part this is because the kind of urgent priorities that developed over the past decade or so for energy materials have not developed for non-fuel minerals.

This situation is changing however. Increasingly, there are requirements for a better understanding, in quantitative or qualitative terms, of the mineral resources that are likely to be contained in a given mining camp, area, region or jurisdiction. This information is needed for a variety of reasons ranging from the purely technical to those that relate to economic and political decisions.

Experience at the Geological Survey, particularly with the northern studies referred to above, suggests that assessments that yield informed judgments about the relative 'values' of lands in present (i.e. known resources) and future (undiscovered resources) terms may be generally the most useful in government planning and policy decisions bearing on land use allocation. They will probably also be (ultimately) most useful to industry clients from the viewpoint of the identification of mineral exploration target areas. The reasons for this are essentially that the problems involved (competing uses for land; 'favourability' for mineral exploration, etc.) are generally amenable to qualitative solutions. The purpose of this type of regional assessment is not to locate the

needle in the haystack and speculate about its worth, but rather to identify the haystacks that are more likely than others to contain needles. Finding the needle is the prerogative of the exploration industry.

As an illustration, figure 14 is a simplified sketch of a relative potential (minerals, oil and gas) map of a part of northern Yukon Territory in which a new national park has been proposed. The proposed park area includes the northern end of the Mount Sedgwick-Barn Uplift-Driftwood High belt that was identified as having the highest relative potential for minerals (chiefly lead, zinc, copper, tungsten and uranium) in the map area (Geological Survey of Canada, 1981a). The overlap zone at the north end of this belt ('3' of figure 14) is thus in (potential) land-use conflict. On the one hand it has some present and future 'value' as part of the proposed national park. On the other hand, it has forecast future 'value' from potential mineral production. The 'values' involved cannot be computed in economic terms, except indirectly, artificially, and probably wildly inaccurately. But the exact nature and geographic extent of the problem area can be defined and clarified through the assessment process and whatever other sets of factors are relevant can be applied in making a policy judgment as to the wisest use of the land in question.

There are, however, situations where quantitative answers will be required. Examples have been cited in the case of energy materials (oil and gas, coal, uranium). In general the requirements for quantitative estimates will be linked with policy applications in the supply of materials. In such cases, however, the basis for policy decisions will, wherever possible, be the part of the assessment(s) that deals with 'reasonably assured' resources. The more speculative prognostication of resources made in frontier areas, because detailed geological and metallogenic data bases are lacking, must be used with caution. This, for example, is the current situation with regard to the use of uranium resource assessments in domestic uranium supply allocations.

Quantitative assessments may prove useful in attacking aspects of the problem of single-industry communities whose established mines are running out of ore. Applications here, however, require a well-tested deposit-model and a detailed geological knowledge base. Sangster (1980) for example has suggested that the tonnage/grade and distribution characteristics of volcanogenic massive sulphide deposits (Cu, Zn, Pb, Ag) typical of major Canadian mining camps (Noranda, Flin Flon, Bathurst, etc) can provide the basis for quantitative estimates of resources remaining to be discovered in similar mining camps or districts.

Some broad relationships between resource assessment processes and policy generation processes are suggested schematically in figure 15. In figure 15a the 'Mineral Policy and Planning Process' (MPPP) is shown as depicted in the back-

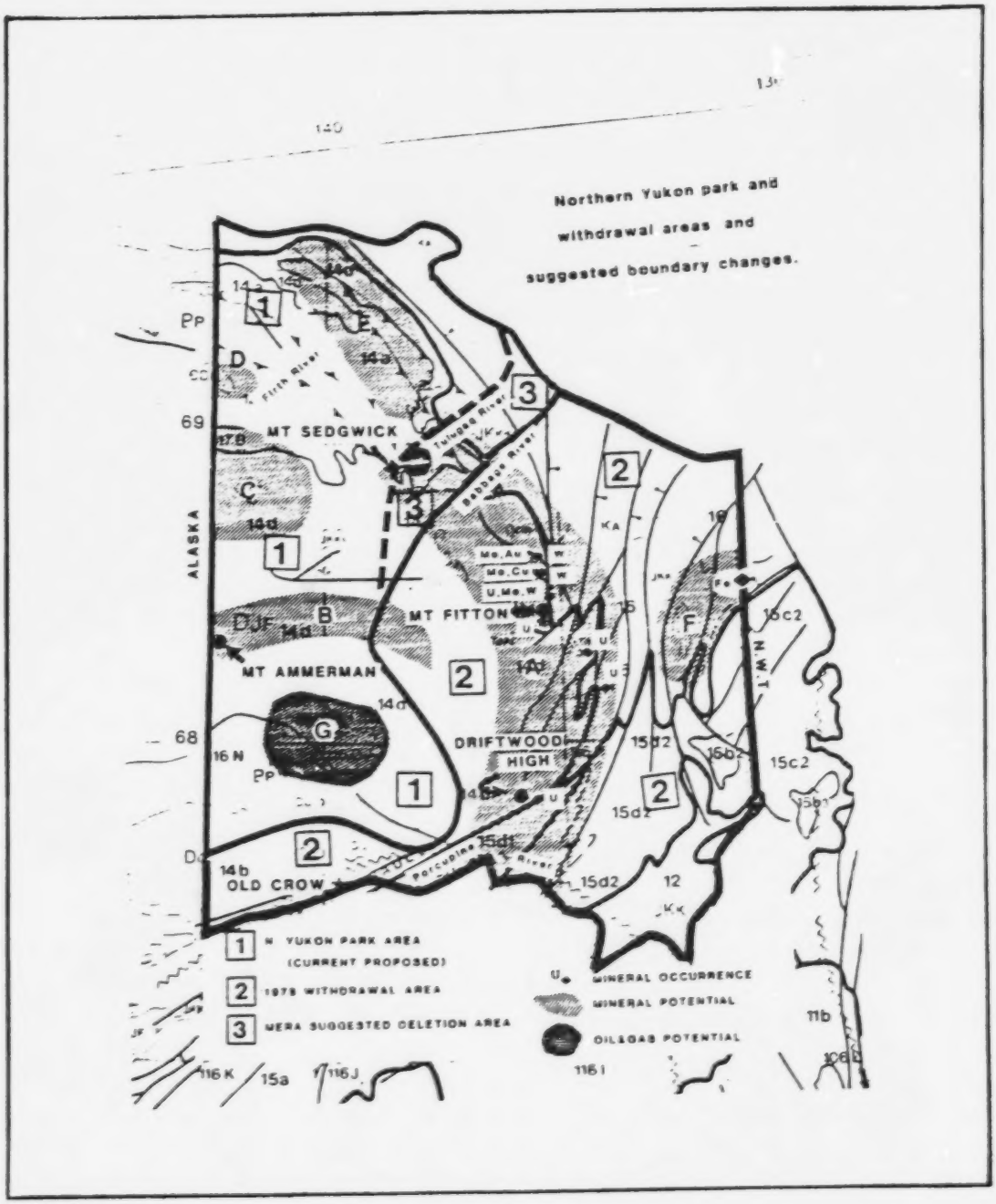

Figure 14. Generalized relative potential (minerals, oil and gas) map of part of northern Yukon Territory containing the proposed northern Yukon National Park. The area designated '3' is a zone of relatively high mineral potential that currently lies within the proposed boundaries.

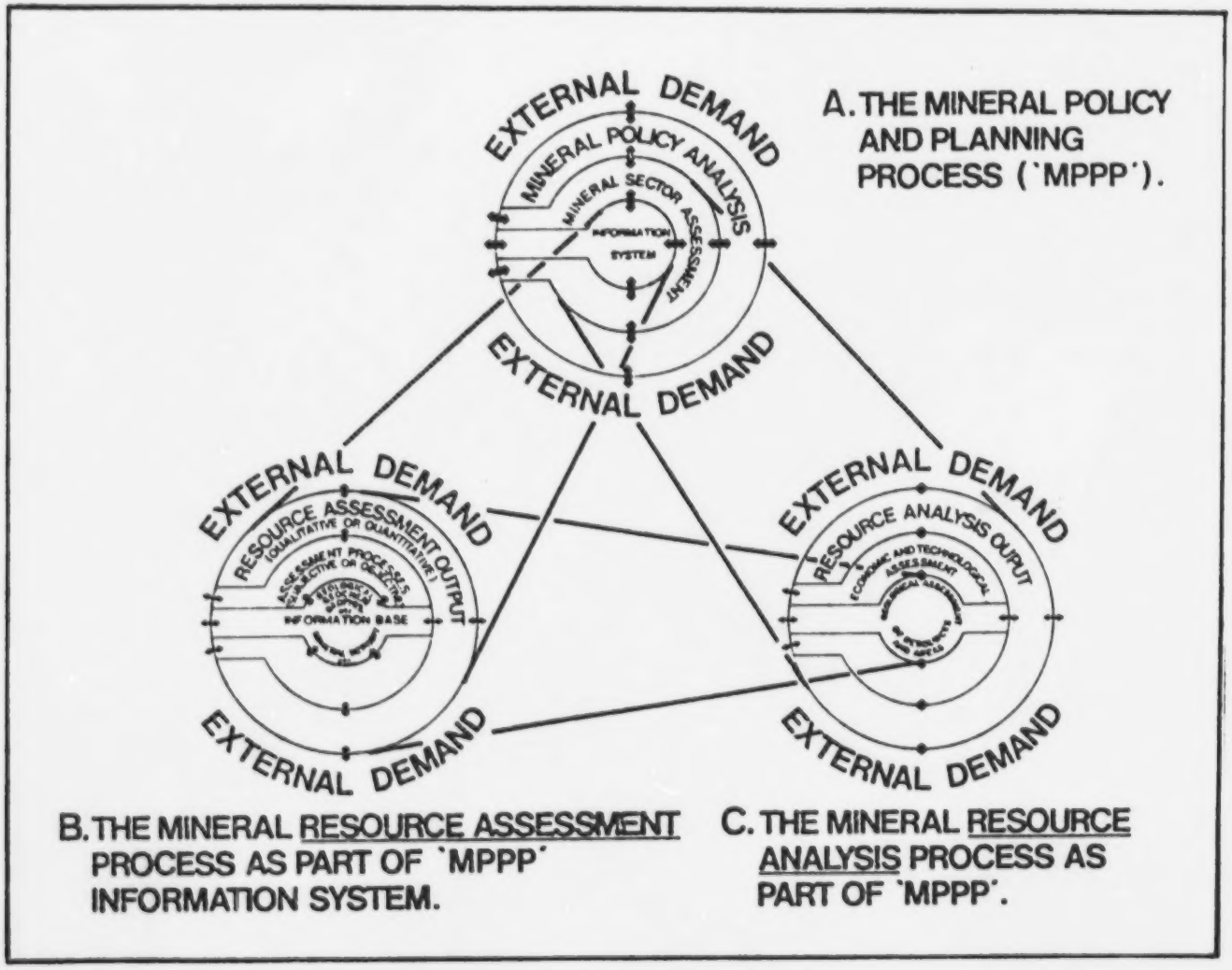

Figure 15. Relationships amongst the 'Mineral Policy and Planning Process' (Figure 15a) mineral resource assessment (Figure 15b) and resource analysis process (Figure 15c).

ground note for this seminar by B.W. Mackenzie. Figure 15b, lower left, shows the mineral resource assessment process as a component of the Information System of the MPPP (figure 15a). This information: a) feeds further 'mineral sector assessment' (middle ring of 15a); b) enters directly into policy analysis (outer ring of 15a); or c) is absorbed directly by the client ('external demand' area of 15a). The GSC northern Canada assessment studies used as examples in this paper fall mainly into category c) above. That is, they are provided directly to the client (e.g. Inuit Development Corporation; Department of Indian Affairs and Northern Development; general public) where they are used at the client's discretion and for the client's purposes. These purposes may or may not be directly related to MPPP.

Figure 15c is a slightly different perspective on these relationships. Here, the resource assessment process of 15b is seen as the core (inner ring = information system) of a larger process that is roughly analogous to the middle ring ('mineral sector assessment') of figure 15a.

For convenience it is referred to as 'resource analysis', the distinction being that it includes, in addition to the basic geological assessment of resources, other assessments generalized as 'economic and technological' (Findlay and Walsh, 1979). In practice, however, these additional assessments could involve the consideration of any other factors that could affect the exploitability of resources (known and undiscovered) of an area, region, jurisdiction or even country. 'Political risk analysis', for example, might be a component of this part of the process. An example of a policy that might use such an integrated assessment-analysis stream would be government measures to aid mining communities threatened by exhaustion of ore reserves. The base of the process would be quantitative assessments to obtain estimates of resources remaining to be discovered in the camp or district. Various other analyses (social, economic, technological) would then be applied to determine the economic benefits (to the community) that would be expected from finding and exploiting such additional resources. This would be weighed against expected costs in terms of government subsidies and incentives towards exploration and development. Rigorous analysis of this type might aid in determining 'good risk' as opposed to 'poor risk' camps and communities.

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GOVERNMENT INVOLVEMENT IN MINERAL SCIENCE AND TECHNOLOGY

by

W.G. Jeffery

Introduction

Science and Technology

In keeping with good practices of scientific logic, it is appropriate to be sure of what we are talking about when we speak of the subject of this presentation; namely, Government Involvement in Mineral Science and Technology. In my view it is useful to think of a range of activities that are embodied in the words: knowledge, research and technology. We have three categories:

i science knowledge, which requires the gathering, processing, collating and presentation of data;

ii scientific research, which is creative work undertaken on a systematic basis to increase the stock of scientific knowledge;

iii technology, which may be described as the use of knowledge to modify the physical world. Technology may be hard (e.g. machinery and equipment), or soft (e.g. processes and ideas).

Knowledge and Research

Scientific research is done on the basis of science knowledge. Scientific research leads to new technology which can then be applied or transferred.

Hence, all three components merge together. Nonetheless, it is true to say that one can have dominantly science knowledge and research institutions, as well as institutions that are dominantly oriented to research and technology.

For example, within Energy, Mines and Resources there is now a broad organizational division between the Earth Sciences Sector and the Research and Technology Sector. The difference between science knowledge and research institutions on the one hand, and research and technology on the other hand is by no means clear cut; it is a matter of emphasis and dominance in approach.

Another point to be made is that the intellectual demand for all who are involved in this range of science and technology is no less for any one activity than another. The most rigorous and the highest standards of scientific training are essential for those who identify, assemble and present scientific data and knowledge, just as much as they are for those involved in all manner of research.

Government Involvement

In the large picture, all modern governments are involved with science and technology in the broadest sense. The realm of science covers all the socio-economic objectives of government from general advancement of knowledge through resources, health, industry, defence, transport and communications, environment, earth, and atmosphere. Table 1 gives some research expenditure figures from OECD countries.

As with all statistics, these are subject to much debate. For example, the amount of hi-tech knowledge that is involved with defence research must clearly have been growing very rapidly, and this has an overlap with the category of civilian industry. Nonetheless, it is interesting to note differences in expenditure that reflect the size, climate, resource endowment, and position in the world pecking-order of different countries.

Table 1 indicates the large proportion of research and development expenditures for the general advancement of knowledge; this represents a substantial part of government funding in universities as well as some government agencies. It goes without saying that knowledge is useful, either as the collection of facts (about a country's natural endowment for example) or knowledge derived as a result of research.

Scientific knowledge is the data base for research to develop new technology. The search for new technology, whatever the field of endeavour, is motivated in the private sector and indeed within the public sector with more complicated criteria, with the hope of a suitable return on the investment. This is not achieved if successful research leads to good technology but is not followed up by its transfer or, in private sector terms, its commercialization.

However, there is no guaranteed order of sequence in scientific and industrial development. There are examples where scientific knowledge languishes for decades before its application to new technology; other examples show that certain processes have been known to work by rule of thumb and have been applied before the theoretical or scientific explanation is discovered.

TABLE 1

GOVERNMENT FINANCED EXPENDITURE ON R&D BY SOCIO-ECONOMIC OBJECTIVES IN SELECTED MEMBER COUNTRIES (1979)

Objective	Canada	France	Germany	Japan	Netherlands	Switzerland	U.K.	U.S.
General advancement of knowledge	25.2	25.3	51.0	55.8	57.1	36.9	21.4	3.9
Agriculture & Health								
Agriculture, Forestry Fishing	16.1	3.9	1.9	12.7	8.8	13.9	4.4	2.1
Health	9.3	4.5	3.3	2.9	0.0	3.3	2.1	11.6
Total	25.4	8.4	5.2	15.6	8.8	17.2	6.5	13.7
Defence	6.1	29.5	11.1	2.2	3.6	15.2	48.9	49.8
Civilian Industry								
Industrial Growth	15.3	11.8	7.4	6.5	5.3	6.5	10.3	0.5
Production of Energy	13.4	8.5	10.6	7.3	2.2	10.0	6.5	7.0
Civil Space	0.8	5.5	4.3	6.8	2.9	3.7	2.3	13.8
Total	29.5	25.8	22.3	20.6	10.4	20.2	19.1	21.3
Quality of life								
Transport & Telecommunications	5.6	3.1	1.5	1.8	1.8	5.9	0.6	3.1
Urban & Rural Planning	0.7	1.5	1.1	0.6	3.6	1.1	1.9	0.5
Environment protection	4.6	0.9	1.0	1.5	6.0	3.0	0.6	2.9
Social development and services	0.7	1.4	4.9	1.2	6.2	0.4	0.9	1.9
Earth and atmosphere	3.1	3.2	1.8	0.8	1.5	0.2	0.7	2.8
Total	14.7	10.1	10.3	5.9	19.1	10.6	4.7	11.2
Not specified	0.0	0.4	0.0	-	1.2	-	0.0	-
Grand Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: OECD

Government gets involved in research and development because it can afford to take a longer view than industry. The potential existence of barriers to commercialization are factors that inhibit private sector R&D. Government also works on R&D that is socially desirable such as for health and safety, environmental control, setting of standards and other government objectives. The more industry is unable to capture all the benefits from its R&D, the less likely it is to choose that route in its R&D endeavours.

Governments have historically been involved in research in agriculture, health, defence, earth sciences, and climate. Depending on importance in the economy, other science areas have been fisheries, forestry, mining. More recently, energy and industrial aspects, as well as social development, have been included.

Much of this applied science, for instance in today's preoccupation with biotechnology and energy, rests on fundamental knowledge in physics, chemistry and the like. Today, much depends on advances in computer technology, and this has become indispensable to every field of research endeavour. Wherever this kind of scientific knowledge and research has a broad social implication, the tendency is for science support from government to foster a national capability in R&D.

Private Sector Role

With these thoughts in mind, it is possible to distinguish between private and public motivations in R&D. In general, the private sector will seek relatively short-term pay-off research, the kind that can be identified as of lowest risk, and the kind whereby the corporation can, over the short term at least, capture as much of the industrial benefit as possible. It follows that government R&D should follow the opposite concepts, especially the pursuit of science that relates to social goals and objectives.

These observations are generalizations; clearly some large corporations of the private sector take a long view in their research and know that they must underpin their search for applicable technology with basic science capability. Likewise, government will, under certain conditions (often politically expedient ones because the half life of politicians tends to be relatively short) support short-term science.

Definitions

Let us turn now to the definition of various forms of research in government. I am sure there are as many definitions as there are dictionaries, but the ones I

will quote are those defined by the auditors of the Auditor-General in the Canadian government.

Research and Development: Creative work undertaken on a systematic basis to increase the stock of scientific knowledge and technology.

Basic Research:

i free basic research:
seeks to discover hitherto undiscovered phenomena, structures or relationships; if successful will add to the store of human knowledge; is based on intellectual curiosity rather than on pre-defined practical objectives; results are made freely available in open scientific literature; the time scale of ultimate application to economic or other purposes may range from a few years to an indefinite future; outputs of the research are unknown up to the point of their achievement.

ii targeted basic research:
has all the characteristics of free basic research but is constrained within the bounds of a specified field of interest; often has a time constraint associated with it that is absent in free basic research.

Applied Research (mission oriented research): original research, seeking to acquire new knowledge, but differing from basic research in having a specific purpose such as the creation of a new product, process, procedure, scientific regulation or the gathering of specific data.

Development: drawing systematically on known facts from previous research, development is directed towards demonstration of feasibility of new, or substantial improvements to, existing products, processes, procedures or systems.

Technology Transfer: the process by which technology, developed as a result of government research and development, is made available to organizations in the private sector for industrial and commercial use, as well as other government departments and research agencies.

Innovation: The total process by which a new or improved product, process or procedure is introduced into a known or postulated market.

Mineral Science and Technology

Scientific Knowledge

Geoscience

The full comprehension of Canada's land mass and offshore zone of sovereignty can only come from a data base that represents the accumulation of scientific information. Geoscience data are the raw material for this understanding, and every nation involves itself in the acquisition and collection of such data, whether it be for aquifers for water supply in Egypt, sedimentary rock sequences for petroleum in Indonesia, or gravel deposits in the MacKenzie Valley. To government, knowledge of resources is much more than knowing how many tons of copper exist; a recent review has given a very broad definition to 'earth sciences' in that the expression can include geodesy, surveying, remote sensing, geology, geochemistry, and geophysics; indeed, all the disciplines that study the earth's surface and subsurface. In this presentation I am using the heading 'geoscience' to include this range of knowledge. Geoscientific knowledge is a fundamental base contributing to the economic policies of the energy and minerals industries as well as the environmental and regulatory responsibilities of government.

There remains the crucial question of the relative roles of industry and government in the collection and storage and disclosure of geoscientific information. Apart from questions as to private and public ownership rights to geoscience data, there are immensely important questions as to the integrity of data, how consistent and comparable are the data, who benefits, and who should pay for the data.

In Canada both federal and provincial governments are involved in the acquisition of data, as well as the exploration industry. It is a multimillion dollar business that is basic to substantial portions of the Canadian economy and to aspects of health, safety, the environment, and regulation in our society.

Geomaps

The name 'geomaps' is useful because it follows 'geoscience' nicely. However, it is representative of the process by which all the geoscience data are assembled and presented. In this day and age I do not need to enter into a description of all the myriad techniques by which data may be classified, stored and retrieved. It is safe to say that, for all geoscience data, every method is in use.

One visible and attractive and readily recognizable way to present geoscience data is in the form of maps. Perhaps my geological colleagues will despair of my presenting the discipline in such a simple manner. Today there are geo-mathematicians, and computer specialists, and material is massaged, manipulated and digitized. Nonetheless, while this is true, there is a particular beauty to the geologist and to the surveyor in the form of a map. It represents the organized expression and presentation of raw data, collected carefully, methodically and scientifically, about the geoscience of the nation. A good map is an art form in itself, as well as the product of true science. So my section on geomaps covers all maps, large scale to small scale, on all geoscience, and it represents the fact that raw data are of little value unless they are classified, assembled, and available for presentation to the ultimate consumer. Once again, provinces, governments and industry perform this function, and, once again, it is of value to a nation only so long as there is a consistency of standards and of correlation. Geoscience information in presentable form has value in itself, but as we all know, it can have an immensely greater value than its collection cost because of the interpretation and use that the trained scientist can make of it.

Geoappraisals

This brings us to the third title under 'Scientific Knowledge', which is that of 'geoappraisals'. We now approach the borders of research, and, with some validity, there are those who would argue that the application of any interpretive ability to organize data should be classified as research. This is especially true when the scientist extrapolates from known data to forecast or model other data, or develops a number of hypotheses based on incomplete information. However, I am here speaking of the appraisals that can be made directly, from organized data, such as to establish rock sequences, or surficial material distribution, or the pattern of lineaments from satellite imagery; in other words, the direct reading of raw data without application of other scientific data or disciplines such as physics, chemistry and mathematics. The actual appraisals may have significance for mineral deposits, pipeline routes, damsite foundations or shipping channels, but what they are doing is conveying useful information.

Research and Technology

Scientific knowledge across all disciplines can be assembled and manipulated in the process of research and gaining new knowledge. The application of this knowledge leads to new technology.

Earth Science Research

The geoscientific data base provides the earth scientist with the information to build new earth science concepts, about how rocks deform and fail, about how life forms evolved, and about the true nature of the crust of the earth, and how continents change and mountains form. Government supports this form of research in geosciences much as it does in all other scientific disciplines, in some part within government organizations, but a great deal in financial support to universities, where the benefits derived from the creation of new knowledge are augmented by the association of the process with training and education.

Earth science research also includes the integration of geological, geochemical and geophysical data so as to allow enhanced information displays and improved interpretation. Such research leads to more accurate methods of resource assessment and the identification of the availability of mineral resources. Inventories can be established and ways of making estimates of undiscovered resources can be determined. From this kind of research, the policies and actions can be made that relate to such diverse aspects as exploration incentives, national parks, land claims, environmental control and waste disposal. Apart from direct interest in the search for new mineral and energy deposits, these kinds of objectives are those of governments, and consequently the bulk of such earth science research rests within government and the universities.

Mineral Exploration

The spectrum of activity in the mineral and energy resource system commences with exploration for deposits. Whereas it was once the field of the prospector who had a basic knowledge of mineral recognition, a hammer, and a sturdy constitution, it is now a sophisticated technological field for geologists, geochemists, and geophysicists. The push is to develop instruments that measure all types of physical properties in order to delve deeper into the earth's crust to provide clues and indications of hidden mineralization. There are now airborne, ground and drill-hole electrical, electromagnetic, magnetic, magneto-telluric, gravimetric and seismic instruments. Canada is a world leader in exploration technology, and there is a strong industry component. Government, mainly through the GSC, has been heavily involved in providing the initial impetus to new technology to which an eager industry has contributed development. The technology transfer component in exploration has seemingly been rapid, even though the development process from basic R&D to demonstration is generally of the order of 10 years. Transfer is possibly easier because, compared with industrial processes, the required investments are not large and the equipment is small and, naturally, portable.

Exploration includes diamond drilling and the major research is carried out by the larger diamond drill manufacturers themselves. In recent decades, the major advance has been the wire-line drill which reduced the need to withdraw the drill string. As for actual penetration techniques, there has been no economic advance from the technique of grinding the rock and washing it away, although sonic techniques, lasers and super hydraulic jets have been touted from time to time. It is a matter of energy, cost, portability, and self-containment ability in remote locations; drilling is a highly specialized business.

While research can be encouraged by government contracts (such as a recent description of a bit recoverable through the drill string, sponsored by a U.S. government grant), I suspect that the hands-on research will remain in the industry. What needs to be done, and no doubt will be done in a research environment such as a government laboratory or university, is basic research in fracture mechanics and the way rock breaks or spalls under a variety of physical conditions. The reduction of the energy component in penetrating rock will lead the way to radical new technology.

Mining Technology

Canada is one of the world's leading mining countries in the world, third in production after the USA and the USSR. There are, in Canada, about 300 underground and open pit mines, and it is only natural that Canada is deemed to be very knowledgeable in mining technology. This technology ranges from highly specialist studies such as rock mechanics, and the behaviour and properties of non-uniform materials, to very practical mining problems which verge on refinements and adjustments to operating practices. There are two fundamental drives to seek better mining technology. The first is to reduce costs, to improve productivity and output, to become more competitive; and the second is to improve worker safety in a potentially hazardous environment. Another aspect of research in mining technology is that the ultimate test of effectiveness can occur only at an operating minesite; indeed much, but not all, research can take place only at the mine.

For these reasons, the research location and the objective of the research, there tends to be a division between government and private sector R&D in mining technology.

Government involvement provides certain supportive specialist roles, where parts of the research can be carried out in laboratory conditions. Examples are rock mechanics and strata control, dust, gases and radiation evaluation, and explosives research. These experts can then work in cooperation with mining compa-

nies which do not need, nor can they afford to maintain, such specialist research in full-time capacity. However, the mines have the operating environment, and their management identifies and attempts to solve their own particular operational needs for improved ways of extraction both for production purposes and for safety.

The complexity and relatively heavy investment required for research equipment and facilities is such that the federal government has tended to provide national facilities in this field. Interest at the provincial government level has been small, although various Crown corporations involved in mining perform as much mining technology research as any of their counterparts in the private sector.

Processing Technology

The recovery of the valuable constituents contained in ore from the mine, so that these metals and minerals can be sold to consumers for direct use or manufacturing, constitutes the science (or art) of mineral processing. In this general review it can constitute the initial separation, concentration and beneficiation commonly done at the mine site, plus the smelting and refining to recover pure metals. All major mining companies are heavily involved in trying to find improved and cheaper ways of mineral extraction. The facilities and equipment required are extensive, and generally cannot be supported by smaller companies.

Government involvement, at both the federal and the provincial level, has historically provided a helping hand to smaller companies and in the effort to develop new, and initially smaller, deposits.

However, the nature of mineral processing research is unlike the mining technology component, in that it can be carried out almost entirely under laboratory conditions. The fundamental ideas are based on known chemical and physical laws, and a core capability in what might be termed pure research is essential to the innovative process. The skill and art of taking the bench-scale experiments through ever increasing quantities of material to proven demonstration levels calls for considerable engineering skill and highly specialized knowledge in all elements of mineral processing. Today the multidisciplinary approach is even more essential as we move from the tried and true mechanical and chemical processes of the past to new avenues such as microbiological processes.

Advanced capability in mineral processing research can permit minerals in the ground, otherwise unproductive because of low grade or complexities in extrac-

tion, to become valuable resources for the creation of employment and wealth. It can also be equivalent to searching for and discovering entire new orebodies, wherever processing research can substantially improve the recovery of valuable metals from ore. Government involvement in this field is one of help to small industry, developing new resources, improving good use and conservation of a nation's resources, and finding ways to solve the environmental problems imposed by mining and processing activities.

Health, Safety and Environment

Clearly the subjects of health, safety, and environment cover the entire range of our society and all its activities. However, I consider that their identification within the overall framework of mineral science and technology is warranted because the extraction and use of nonrenewable resources are major contributors to health, safety, and environmental problems. They are the concern of all parts of our society, both private and public, but the demands of the public for safe standards, and for uniform rules of application fair to all, call for extensive government involvement. The effect of the social and economic impacts of health, safety, and environment matters can markedly affect mineral policy formulation.

All components of the mineral system are affected, but health and safety are dominant in mining, and environmental concerns are most significant in the treatment and processing of ores. We cannot ignore the extent of government involvement at all levels.

Impact and Relation to Mineral Policy

Time Frame of Policy Formulation

Mineral policy formulation comprises a large array of factors that impinge upon the mining industry: technical, social, economic, commercial, legal, financial and political.

Inevitably, when one is involved in the mineral policy process on a day-to-day basis, the elements that are foremost and most pressing are those of an immediate nature. From a government point of view they are dominantly economic, social and political.

In a longer, but still short, time framework of week to week or month to month, one is concerned with financial, legal and commercial aspects. From year to

year interest becomes more technical, with concern for the waxing and waning of new discovery rates, claimstaking as a measure of exploration health, and the annual changes in national ore reserves, as well as the variations in world competitive ability of the industry and the trends in world shares. It is only on a decade-to-decade basis that the full impact of science and technology is felt. But a decade is really the most fundamental time frame for the overall exploration, development and production cycle of the mining sector. And therein lies a problem, because, as someone once said, 'in politics, a week is a long time'.

Research for Knowledge

Knowledge of the nature and extent of the mineral resource base is essential for long-term mineral policy formulation. In effect, the collection of scientific and technical knowledge by government is an investment in the nation or the provinces, to be used in planning future growth and development.

In economic terms the expression most used for the government role is that of 'public good'. In terms of knowledge accumulation (as opposed to technology research) the field has been left almost wholly to government. The private sector draws upon this well of information to initiate exploration. In the process, the private sector collects more detailed information; while much of this is proprietary, over time a considerable amount becomes public and is incorporated into the public data bases and presentations. A key governmental role is in data standardization, and in ensuring geoscience data availability.

Research for Technology

This activity is shared between the private and public sectors, but the roles of each are fairly clear-cut. The private sector looks upon R&D as an investment in corporate future, and in improved returns and profits. R&D will be undertaken on the basis of specific judgments as to likelihood of success and how much of the resulting technology the company can control.

Government also has a 'public good' role to undertake for society as a whole those R&D activities that can be identified as national investments. The private sector will be unwilling to undertake R&D that is too broad or too long term. The research may be high risk, too high for the private firm which may fail completely if unsuccessful. The research may require large or unique facilities suitable only for national construction, e.g., a large telescope, a wind tunnel testing facility, a uranium enrichment plant. Government has a role

in R&D that leads to results that apply to broad social objectives or are distributed across a sector. Such is the case with many aspects of technologies for exploration, for mining and for processing.

Risk and Success

There are some published facts and figures related to R&D success, but those that exist usually refer to the more measurable results in such industries as chemicals, drugs and electronics. Although the figures vary greatly, the overall impression is that the likelihood of economic success stands in the order of 20 percent or less. Of course there are other criteria. First there is technical success, and this varies depending on whether one is looking at research for modest advances or brand new major ideas. Commercial laboratories seeking relatively modest advances in process efficiency seem to have a technical success rate of 60 percent.

Then there is commercial success or implementation, and it has been suggested that this may be achieved with perhaps 30 percent of the original projects, i.e., about half of those achieving technical success. However, of all R&D projects, only about 10 to 15 percent at best come through with an economic profit. These figures stem from an investigation of private sector R&D, and it must be assumed that, with the greater risks of some goverment R&D, the public sector figures are likely to be lower. One must also take into account the fact that some government R&D is performed for regulatory or legislative purposes, although such research work can be equated to commercial success when the results are put to use.

Priority Setting

The process of selecting and choosing from among many research avenues is one of the most critical functions of an R&D manager. The decisions are inextricably bound up with assessments for potential success and failure. Indeed, the setting of priorities on research projects is not too different from many other kinds of choices that must be made on either short or long-term outlooks. The professional manager of investment funds must gather together the myriad data available, both micro and macro, to make judgements on purchases and sales. Likewise the R&D performer, knowing the overall mandate, the objectives, and the customers, must assemble the factual evidence that leads him or her to initiate research.

The private sector naturally makes its choices with emphasis on the private rate

of return. Many complex mathematical models have been applied to this problem of decision-making under conditions of uncertainty, but there is no widely accepted procedure.

However, efforts to apply economic evaluations and financial techniques to project selection are widespread. Commonly, there is one element that gets left out of these analytical methods of setting priorities: the scientist knows that the 'unsuccessful' projects usually provide valuable information for the next step and the next round of decision-making.

Government R&D has a broader and more imprecise base on which to set priorities; the choices can be made on estimates of the social rate of return. However, the analytical problems for such calculation are considerable and cause much debate among our economists. My point here is that this less precise environment for government R&D is the very reason why research organizations can be assisted by clearly articulated policy goals and objectives from the political levels. In other words, the mineral science and technology imperatives can be assisted by the policy of the day in relative terms such as emphasis on health and safety, or productivity, or assistance to regional mining problems, or attempting to develop marginal deposits in order to reduce dependence on imports. However, since all these aspects, and more, normally are included in policy wishes by government, the guidance received is one of emphasis on directions of research .

Policy and Technology - Horse or Cart

In reaching the close of these remarks on government involvement in mineral science and technology, some general comments on the preoccupations of policy makers and the scientists can be made. There is no doubt that there is a gulf between the two domains, and one is constantly asking how that gulf can be bridged and the road kept open for a two-way flow of ideas and information.

There are two fundamental differences which make the bridge building difficult. The first and most fundamental is the immense gap in the time frame and the pace of events in the work of the two areas. The second is less precise but is nonetheless of prime importance, and it is the difference in the set of values and the personal objectives of the people who tend to migrate into these distinct occupations. Neither set can be regarded as of less value than the other, although it is only human that each side will make claims for its own values.

All this is to say that the bridges must be built and the linkages made, but one cannot assume that, once made, the links between policy formulation and science and technology will flow with little further effort. Because of the differ-

ences, there is a requirement for senior managers to keep working at it all the time; a continuing effort must be made. In my view, if this is done, then both policy formulation and the science activity will be that much better for the effort.

Government Role in Mineral Science and Technology

Finally, this presentation should end with some attempt to clarify the role of the public sector in mineral science and technology. Frequently the question arises as to why research is not left to the private sector. The following rationale is an attempt to bring out those aspects which the private sector cannot be expected to carry out. The emphasis is on social and sovereignty considerations, but there is an important role related to long-term economic and national competitive objectives. Although my remarks are oriented to the mining industry of Canada, there is no doubt that these reasons for government involvement in science can be applied to a more general and widespread role in research and development.

The main reasons for public interest are as follows:

i the need to invest in the 'well of knowledge' of mineral and earth science in order that data and research can lead to technological options which may generate economic activity;

ii the need to provide scientific facilities or expertise to the private sector where no one private establishment or provincial jurisdiction could justify such capabilities;

iii the need to provide mineral and earth science information and technology input to policy formulation;

iv the need to accumulate data and develop technology to discover new mineral resources or improve productive efficiency, especially in marginal, problematic or non-conventional resources, for conservation, environmental or regional benefit requirements;

v the need for R&D to secure the wellbeing of Canadians in such matters as industrial hazards where these are not being adequately met by the private sector;

vi the need to open, and keep alive, technological options otherwise rejected by the private sector, as a national protection against unforeseen technical or economic problems in the more promising technologies;

vii the need to support the R&D needs of small and medium-sized Canadian firms that cannot pursue R&D independently and where economic performance can be improved by better technology or know-how;

viii the requirement under legislation for R&D in connection with the setting of industrial standards and for regulatory matters.

MINERAL MARKET RESEARCH AND STRATEGIES

by

L. George Bonar

It's both a pleasure and an honour to be here with you today. When I was invited to speak here today, I couldn't help but think of the story I once heard about a concert violinist. He was a renowned performer, a maestro who had performed with some of the greatest philharmonic orchestras of the world. He agreed to do a record one time, without finding out who he'd be playing with. At the appointed hour he showed up, and I'm sure you can imagine his surprise when he found out that he would be working with a rock and roll band -- a famous one, true, but still ...He was stunned. But the band leader put it into perspective for him when he said: 'Hey, man. Not to worry. You just tickle that fiddle and follow your notes -- and we'll make beautiful music together.' And that's exactly what they did. In fact, the maestro found that he could offer his skills in a few places to make the score even more beautiful.

We in industry, and you in government, can do the same. After all, we both want the same thing -- that beautiful music of a strong and healthy economy in a strong and healthy country. To make the music, we all have to play -- and be -- in harmony. And harmony, as we all know, is produced when all the separate parts blend together. There is a part for industry. There is a part for government. I would like to talk about industry's part, and how government and industry can work together.

I am sure each of us here today is familiar with the document Mineral Policy - A Discussion Paper which was released in March by Energy, Mines and Resources Canada. I'm also sure that most of you are aware that members of the mining industry, such as Falconbridge, have responded to this discussion paper. I don't want to use your time to repeat Falconbridge's remarks. If you are interested, copies can be made available. Instead, I would like to focus on the basis of policy -- and of making policy.

The most common definition of the word 'policy' is conduct of affairs of state. But according to Holt, Rinehart and Winston's Dictionary of Canadian Usage, policy also means 'wise management of affairs; prudence'. How does this apply to Canada's mineral policy? The same way it applies to the way we at Falconbridge form, adopt and exercise policy: with prudence, or at least as much of it as we can muster.

But all of our available wisdom, prudence, sagacity, experience and good intentions don't amount to much unless they are applied to current and accurate information.

That's why we at Falconbridge, and we in the entire mining industry, spend so much time, money, effort and concern in making sure that the information on which we base our decisions is as up-to-date and accurate as humanly, and, if I might coin a word, 'computerly' possible.

It's easy to see why this current and accurate information is so important to all of us. Our health, our survival as a major Canadian corporation, depend upon it -- as do the jobs we create, the related businesses we support and the income we bring into the country.

Just to remind you of the enormous contribution the mining industry makes to Canada, I'd like to refer to a publication put out by The Mining Association of Canada titled Mining in Canada - Facts & Figures. According to the 1982 edition of that booklet, approximately 131,000 men and women were employed directly in the production of metals, coal, nonmetals, and in the operation of quarries, sand-pits, smelters and refineries in 1981.

The average weekly 1981 wage and salary in the mining industry was $504.43 (based on the first ten months of 1981). That represents the second highest average weekly earnings of all major sectors and is surpassed only by construction. The more than $500 in average weekly wages paid by the mining industry compares to an industry composite average of $352.45.

During 1981, the value of metallic and nonmetallic mineral production in Canada amounted to $13.3 billion. Of this more than $6.8 billion worth was exported. If you add the value of fabricated mineral product exports, the total (not including oil and gas) came to $16.2 billion, or one-fifth of the value of all Canadian exports in 1981.

Think about that figure: $16.2 billion. Even in inflationary times, that is still a lot of money. It is money that we in the mining industry brought into Canada; money that would not have come into Canada without us. Those sales are the result of our skills combined with our data base; our thorough understanding of what those data mean and portend; and our intimate knowledge of the increasingly international market place.

The federal government recognized the importance of Canada's resource industries in its policy paper Economic Development for Canada in the 1980s, which accom-

panied the November budget, and in its discussion of policy for the mineral industry. The further formulation of policies to promote resource development will no doubt require a comprehensive data base and thorough analysis of that body of facts and figures. I believe that we in the private sector must do our part to see that the information that government has about our industry is as accurate and up-to-date as possible. I would be delighted to share some of our information and analyses with you as we both pursue our common goal of growth and prosperity.

We should be working together for this common goal, especially since the job is so much more difficult today because of the fierce competition the Canadian mineral industry is facing throughout the world. Some of these competitors are government-owned companies, especially in Third World and Comecon countries, where governments look upon the mining industry as a way to bring hard foreign currency into their country. They are more than willing to subsidize losses in exchange for that currency and the jobs the industry creates. It is hard to compete with someone who is willing to lose money.

Currently we are competing in a market where prices are particularly depressed. In fact, they have now fallen below actual production costs for many minerals. Thirty years ago, the Canadian mining industry had a solid grasp on international metal markets. But that position has deteriorated over the decades with Canada's share of the non-Communist world market for nickel, asbestos and aluminum showing significant declines. What's more, back in 1950, most minerals went to a stable list of countries. Due to the growth in the number and size of industrialized countries over the past 30 years, today we face not only more competition, but a fragmented market with more buyers.

To a large degree, this is a welcome change, since we are presented with additional business opportunities, but it also complicates our lives. Doing business in each country requires an intimate knowledge of just how business is to be done there. Our salesforce has to deal with more than just language differences; they also have to know the customs, cultures and traditions. So not only do we have a proliferation of producers, many of whom are willing to sell at a loss, we also have a more complex market.

Times change in other ways. Over the past 30 years there have been times when buyers were beating a path to the seller's door. Instead of the current depressed market, there were shortages. And it was the buyers who did the courting, the wining and dining.

At the moment, wining and dining by the sellers will not produce sales. Even discounting may not be enough. The worldwide recession of 1980-82 has severely weakened demand for copper, nickel, zinc, lead and other metals. Prices are

unsatisfactory and have been so for a number of years. While the situation does vary from metal to metal within the mineral industry, for most of the last 10 years there has been inadequate cash generation for proper exploration, development and research -- a situation that could jeopardize the long-range security of supply of metals and minerals.

Our problem, therefore, is two-fold. We not only have to survive the recession, we also have to be healthy enough when it is over to take advantage of the fact that it is over. Ideally, we should be able to judge the extent of the recession, the nature and timing of recovery, and how metal markets and our ability to respond to those markets will be affected. Therein lies the importance of mineral market research and strategies.

The effects of the recession are most dramatically illustrated in terms of people. Recent industry estimates show that about 52,000 people in the mining industry in Canada have been affected by temporary shutdowns or vacation closures and that another 8,200 jobs have been affected by permanent layoff or attrition. The production cutbacks that triggered these layoffs and the loss of jobs themselves will, through the normal multiplier effect, translate into much more than just the loss of jobs and exports.

As I said earlier, I am accustomed to daily doses of depressing news; and the data I see before me every morning are not all that encouraging. Prices are not yet firming; signs of sustained economic recovery by mid-year are absent; production cuts, whether voluntary or involuntary, are everyday news. Within such an environment, both short-term and long-term forecasts, as well as the strategies we must devise in response to them, must vary because of unpredictable events almost anywhere in the world. Thus, the number of contingency plans and planning alternatives which we examine multiply. Our exhaustive, daily gathering and analysis of data from around the globe permit us to keep pace with this ever-changing, volatile situation.

Just as we recognize the crucial role that this type of intelligence gathering or research plays in our policies, strategies and tactics, we also recognize the need for such information in formulating government policies. We have found it useful to draw on government resources in gathering our data, and I would like to reiterate that we are only too pleased to share certain of our information and research with government.

In the fast-changing and uncertain world in which we live, information is not much good when it gets old. Governments publish a great deal of information, but in some cases it is inadequate and it is old. Often, it is more than a year out of date. We can't operate that way. We have to be current, on top of the situation. To stay on top, we have developed our own lines of communication; our own lines of data collection. We have also developed our own methods of interpreting and analyzing those data because we have to understand them if we want to use them properly.

Obviously, with each company doing its own research, in addition to that by government and industry associations, there is bound to be some overlap and duplication. This is not, however, a totally undesirable situation. For while we might well work together to avoid unnecessary duplication, there is merit in being able to cross check certain information and interpretations.

That's only one way in which government and industry can share -- only one way in which we can cooperate. But while cooperation means working together, it doesn't mean that everyone is doing the same work. It's like baseball. You can't play the game with nine pitchers on the field. Just as there are separate and distinct positions and duties on a baseball team, there are separate and distinct positions and duties on our team, the team of the private sector and the public sector, a team that is working together for a common end, a stronger and healthier Canada.

I'd like to take a moment to show you just how good a team we can make, where we each play our proper role. Some time ago we had a problem in India with an import duty on ferronickel. Now industry can deal with industry. In many cases, industry can also deal with government. But in some instances, we in industry must go to our own government and ask it to help us in dealing with another government. This was one of those cases. So we went to the Canadian embassy in India for assistance. Luckily we found a man who recognized what was needed and who acted energetically on our behalf -- the job the Government of Canada had to perform to benefit both a Canadian company and the people of Canada -- and he did it. That man, working with our people in Canada, in the U.K., in Belgium and in India demonstrated to the Government of India that adjusting the import duty on ferronickel would help everyone, and the duty was adjusted. This was an example of active cooperation -- actually working together.

There are other examples of effective cooperation between industry and government. On the federal level, there is the manpower training program. There is also the modular training program system on the provincial level. We have also worked together in the formulation of federal regulations for liquid effluent disposal; and The Mining Association of Canada is currently working with the

federal Department of Indian Affairs and Northern Development on northern mining policies.

We can also cooperate in the way the batters on a baseball team do. Each is at bat alone, but each is still a member of the team, and each is linked not only by a common goal, but also by a strategy. Developing that strategy requires dialogue. Let's look at one of the standard baseball strategies: the hit and run. To make it work, both the batter and the man on base have to know exactly what is happening. If they are not coordinated, signals are not understood, and they are out.

I mention this in particular because I am worried, along with the industry I represent, about the conflicting signals we are receiving from the public sector. Let us take taxation of northern allowances as an example. On the one hand, government is supporting the development of our northern resources. In fact, Ottawa went so far as to allow the northern allowances we pay the people working in those remote areas to be tax free. But now it looks as if Ottawa is making those allowances taxable. We can't back away from those allowances. They are necessary if we want people to work there. In many cases, they are also covered in our labour contracts, with a provision that we make up the amount lost should they ever be taxed.

In my view, the only reasonable solution to this matter is to continue the exemption, and write it into the Income Tax Act itself. Any policy decision to reduce the federal commitment in this sector should be considered as a separate matter. We firmly believe that there should be a moratorium on the matter, at least until the current recession is over.

Another major area of concern is the budget. Nothing that government does affects as many Canadian men, women and industries as much as the budget. We are pleased to see that the Minister of Finance, in his paper on the budget process, recognizes the merits of greater dialogue and consultation, especially in the current economic climate.

I am sure you will recognize that the expertise of those in the mining industry is not limited to mining. Mining includes not only the normal geo-technical functions but also marketing, economics, international relations and taxation. These are all subjects we have to know, to deal with, to be experts in, in order to survive. As I said before, cooperation requires dialogue, and we are willing to share our expertise with governments in all these areas.

We would like this dialogue to be an open and long-running dialogue ranging across the broad spectrum of national and international decisions affecting the mining industry. The subjects of these decisions run the gamut from northern

allowances to the ways in which the government can provide reassurance to investors -- Canadian and foreign investors -- who are considering investing in our mineral resources. Our interests also include private research and development of mining machinery and equipment, and incentives to help junior mines.

We know the mining industry from A to Z -- from Alaska to Zimbabwe. We also know how it affects other subjects and considerations, regarding both domestic and foreign matters. I am referring, among other things, to Third World countries, Law of the Sea, foreign aid and investments, bilateral trade agreements, multilateral commodity agreements, and environmental and health considerations. We do not deny that government has responsibility in certain areas, but we would like to give you our thoughts and concerns about these issues. At times, too, the lines delineating areas of responsibility may become blurred. It is important for all -- both government and industry -- to work together, whenever possible, to clarify where those lines of responsibility should lie.

When we in the mining industry have to set policy, we study all aspects of a situation and collect the pertinent data and information from wherever we can get it. I trust you take the same approach. We have a lot of data and information. We want a dialogue. We want to cooperate.

I am a businessman. I am one of the people who has to work within the regulations and goals of the government of Canada; I am interested, vitally interested, in the nature, scope and formulation of these goals. My interest, obviously, is centred on the policies which the government sets for the mining industry, and to other policies that might have an impact on the mining industry.

The outcome of this cooperation would be a healthier mining sector and greater prosperity for all Canadians -- it would help us achieve that perfect blend of harmony. Like the maestro, we are willing and able to 'tickle our fiddles and follow our notes.' And whenever possible, we would like to offer our skills to help make the music a little more beautiful.

MINE DEVELOPMENT AGREEMENTS BETWEEN GOVERNMENT AND THE PRIVATE SECTOR

by

Dallas W. Davis

Introduction

Having been trained as a geologist and having worked for nine years applying that science before assuming a policy analyst-advisor function with government, I might be expected to place a strong emphasis on the role of scientific and technical knowledge in the negotiation of mineral agreements between government and industry - and I do, but with certain caveats.

A number of the caveats apply regardless of whether analyses are based on scientific and technical data or on economic data. First, in the case of mineral resource development at the stage when agreements are negotiated, there are often insufficient geological data, relative to what is needed to judge viability; and there is a dearth of case histories on the impact of similar developments, and on how government could best ensure publicly responsible resource management in a technical sense. Secondly, there is a tendency to use what data are available to support optimistic hopes in public, even though technical advisors may have private apprehensions.

Thirdly, situations where data are inadequate, or can be used to support various conclusions or policy approaches, have a high inherent potential for use by the most aggressive or convincing advisor or analytical team to impose personal prejudices on government under the guise of unprejudiced analysis.

Another weakness of many government agreements (and policies) has been that they are too dependent, for their political stability, on the technical and economic outcome turning out to be as predicted by the technical and economic advice. Technical interpretations and economic forecasts are taken almost as fact, rather than as probabilities. Perhaps the National Energy Program and the energy agreement with Alberta are examples of what I am suggesting.

To conclude this introduction, I would question the long-term political wisdom of governments in negotiating agreements for each and every mineral development, regardless of the foundation of the technical advice or the information linkages within their organizational structures. Instead, it is my view that individual agreements should be negotiated only during the phase of learning the potential

for a hitherto untested resource or resource class in the jurisdiction, as part of the process of establishing a new policy or otherwise determining what is competitive. Thereafter, relatively standard leasing agreements are in the best interest of any jurisdiction wishing to maintain a stable and positive investment climate.

Establishing a Guideline and Approval Process for Mine Development Projects

Except in certain territories moving toward self-government, one finds most jurisdictions have some existing form of guideline and approval process. In many cases, the department of government responsible for mineral management grants a mining lease automatically upon fulfilment of certain evaluation and expenditure conditions of the mining legislation. Another department, however, under more widely applicable legislation, may have established guidelines and requirements to meet once the lease has been granted, but before production is permitted.

The role played by the department responsible for mineral resources often becomes that of the proponent or 'broker' in interpreting the second department's technical requirements to industry and the technical nature of the development to specialists in the second department.

In establishing new technical guidelines or, more particularly, an approval process for mine development projects, interdepartmental committees of technical as well as nontechnical people are, to the best of my knowledge, standard practice in most Canadian government organizations. A mines department official most likely would chair and have considerable influence over the process. The importance of mines department technical staff in objectively and clearly explaining the nature of their business is critical to the process outcome.

Some governments, in the case of politically contentious issues such as the approval of uranium mining projects, have gone to the public hearing approach. Again, mines department technical advisors can play a very useful role; however, independent or outside technical advice may be more acceptable to the public. In such cases, the linkages between information, assessment and analysis may be outside the organization responsible for mineral policy analysis. The role that the in-house technical and scientific staff are able to play, as information source and interpreter, will depend on how well they have carried out their monitoring, compiling and interpreting of statistics on all aspects of operations.

Negotiating Mineral Leasing Agreements - General Rules vs Ad Hoc Terms

A good agreement is one which will be perceived as fair by both shareholders and the general public, even in the face of variations from the technical premises and economic forecasts at the time of negotiation. Such agreements provide the least ammunition for politicians advocating radical or abrupt departures in policy.

Some general rules which help ensure that agreements will be perceived as fair are as follows.

i If the resource or resource class is relatively untested in the jurisdiction, leave open the prospect for mutually agreeable amendments; or, better still, provide for renegotiation after, say, 10 years from start of production, or upon return of investment plus a specified return on investment, whichever comes earlier. In short, the mining lease term should be adequate to provide the security required by finanical institutions, but not much longer.

ii Establish a royalty or mining tax that will be perceived as competitive, regardless of whether the project achieves, exceeds or falls short of technical and economic predictions of advisors.

iii If the project is the first of its kind and the degree of industry interest is strong, devise a means by which the public can be assured that the royalty or mining tax is competitive. This could involve some bidding process, as used in the case of the Millstream potash deposit in New Brunswick, or a drawn-out and publicly visible negotiating process. This latter approach has considerable potential for eroding the general confidence of investors.

iv Exploration should not be unreasonably prolonged without compensation to the jurisdiction or forfeiture of rights.

v If the type of mine is new and there is a strong potential for other deposits, award of rights should be staged over time, to allow resource management policy to evolve and future agreements or legislation to draw on technical experience.

vi Exploration and mining plans should require advance technical approval of the jurisdiction, in the interest of ensuring fullest long-term resource benefits. All technical data should be filed with the mines department and should remain confidential until rights are forfeited, or until sufficient similar developments have taken place that it becomes unlikely that exclusivity of the data would continue to provide a competitive advantage.

Direct Government Involvement

Personally, I find direct government involvement in mining operations difficult to support rationally, except where declining mining activity leaves the government, for social reasons, as a phase-out operator and risk-taker of last resort.

Even in such cases, there are means by which government can indirectly leverage private exploration investment at less public cost than by becoming a direct exploration spender.

The role of scientific and technical knowledge would be important to the success of government exploration and development activities. However, according to Kalymon (1978) large companies are less efficient users of risk monies than junior companies. Consequently government, in order to avoid even greater inefficiency, needs to devise some means of internal competition among relatively small groups of scientific and technical people, and to decentralize all decision making except the apportionment of funds.

Information, Analysis and Decision-Making Requirements

Unfortunately, at the stage when agreements are made, it is often the case that relatively little is known about the resource or prospective mine. In such cases, the information base, the analysis and the decision making, if they are to proceed from the known, must do so by analogy with similar developments elsewhere.

In New Brunswick, for example, we made our decisions on underground disposal of byproduct salt and the required spacing between drill holes after analyzing experience and technical data from French, German, and English potash mines. Certain of these also provided models of what configuration, mining plan, and costs to expect. At this point, I have the impression that our analysis of costs will prove to have been somewhat pessimistic, if anything. Therefore, it might turn out to be fortuituous for the province that the Millstream agreement avoided the problem of drawing on technical risk assessment.

Government-Industry Dialogue

Industry executives generally exercise their decision-making responsibilities more positively if policy changes are characterized by a history of continuity or gradualness and dialogue.

I have found from experience that industry is willing to provide policy input, whether as the basis for agreements or for legislation of a technical nature. Unfortunately, when industry tries to speak with one voice through its association, accommodation of industry members' views may actually result in a somewhat extreme reaction through the accumulation of what are in effect a set of vetoes. This results from the fact that, almost inevitably, at least one industry representative will be opposed to each individual component of an agreement or policy. Thus government, through its technical people or analysts, must seek the reactions of individual industry members and, in the end, recommend its own compromise which meets approved policy objectives.

In some cases, what government submits to industry as a policy discussion paper reflects an internal consensus among technical and analytical people from various disciplines. Like the compromise or aggregation of vetoes reflected in industry association briefs, it too may appear unreasonable or extreme. I believe policy and technical advisors have a responsibility to carry on internal debate until such documents are defensible, if not entirely acceptable, when released.

Initiating Suggestions for Appropriate Policy Measures

Technical measures which are consistent with existing policy, or for implementing existing policy, readily come up through the line branches of government mineral departments. However, when government asks for a major policy review, my experience is that line people are generally either resistant to change or slow to react in a way that appeals to the Cabinet. This may lead to the formation of an interdepartmental committee which in many cases recommends policy action opposed by the line people.

The senior mineral department staff policy analyst becomes the broker or mediator in seeking consensus and, through judicious utilization of departmental technical input, can achieve realistic or reasonable compromises.

Another approach, when mineral department technically-based people resist change or make proposals which do not relate to the policy intent or style of the government of the day, is to introduce senior staff from other departments and charge them with the policy review. These people may have no previous familiarity with the industry, no technical background, and may be resented by departmental technical staff. An outsider gets the impression that this approach was used by the federal government in devising the National Energy Program.

What is the reason for mineral departmental technical advisors being effectively 'locked out' of the process of critical policy development? Could it be that the elected government suspects the technical advisors are too allied with industry, which in turn they either do not trust or consider too self-serving? If so, it is a somewhat unsettling reflection of the extremity of the adversarial system in Canada. Furthermore, it creates a challenge in objective communications and innovative thinking to which informed scientific and technical staff of minerals departments must rise if the consequences of continued erosion of investor confidence are to be averted.

MONITORING AND ASSESSING THE MINERAL SUPPLY PROCESS

by

J. Zwartendyk

It is generally taken to be self-evident that mineral policy formulation must be based on a clear understanding of our state of knowledge about mineral resources in the ground. At the same time, the connection between the existence and the availability of resources has long been a fertile field for confusion. I will be focusing on the linkage between mineral resources information and policy questions about future mineral supply.

In the following fictitious question-and-answer exchange, a policy analyst is probing for answers, while not being too sure of the question himself (from reference 1, p. 9):

Q.: How large are the coal resources in this region?
A.: 1,200 years' worth.

Q.: At growing levels of consumption?
A.: No, that would be only 250 years' worth.

Q.: Does that allow for future technological improvements in mining?
A.: No, that would stretch it to 350 years' worth.

Q.: Is that recoverable coal?
A.: No, that would be only 190 years' worth.

Q.: Is much of that economically recoverable now?
A.: No, only about 30 years' worth.

Q.: Can much of this be used for steel making?
A.: No, only 10 years' worth, but in view of the miners' strike ...

This parable illustrates that, depending on small variations in the question, the answer may range from one extreme to the other.

There is always pressure to simplify the results of resources or supply assessments for the presumed benefit of those who don't have the time or interest to follow details. Such simplification can have results not at all intended, and at times highly unfortunate. An example is the following statement from a

speech delivered by the Minister of Energy, Mines and Resources to the Canadian Institute of Mining and Metallurgy in Banff, Alberta, on June 2, 1971:

> 'Canada's total oil reserves were 469 billion barrels at the end of 1970 ... At 1970 rates of production, these reserves represent 923 years' supply of oil...'

By the mid-1970s after the OPEC embargo, this statement was exhumed by critics who contrasted it with the industry's figure of about 8 billion barrels in 1975 for Canada's proved oil reserves. The 'decline' from 469 to 8 billion barrels was taken to be proof of industry's incompetence in estimating how much oil we had in Canada and of its ability to hoodwink a naive government into believing any estimates presented.

It is quite unnecessary to suspect malice behind such baffling switches in figures. The usual reason is nothing more sinister than carelessness in interpretation and communication. In this case, too, the statement by the Minister may have come about in three simple steps (this is my own unsubstantiated theory).

i The person writing the speech composed a statement, saying that export of oil was justified in view of the immense potential for oil in Canada. The intention was to reassure the conservation-minded.

ii A request for some numbers to express this 'potential' led to a consultation of the then latest source, a 1969 report by the Canadian Petroleum Association. This report contained the following figures, in separate chapters, which our speechwriter selected for his use:

billion barrels
(recoverable oil)

300	oil sands (with max. 2500 feet of overburden)
30	Cold Lake (heavy oil)
120	conventional oil ('potential reserves')
19	natural gas liquids ('potential reserves').

The first two figures had been taken from earlier studies (1963 and 1967) done at the Alberta Oil and Gas Conservation Board; less that one-tenth of the 300 billion barrels in the oil sands could be obtained through open-pit mining (max. 150 ft. overburden). The last two figures were estimates provided by the Canadian Petroleum Association; 'potential reserves' referred to all the conventional oil (and natural gas liquids) that might conceiv-

ably exist, of which less than one-tenth was designated as 'proved'. So, the bulk of these quantities was either beyond economic reach for a long time to come, or was only a geological possibility.

iii A final speechwriter 'polished' the text, simplifying it by adding up the four above figures into the glorious total of 469 billion, and by replacing the descriptions by the carelessly chosen label 'reserves'. He then tried to provide a sense of the magnitude of 469 billion by expressing it as 923 times last year's production.

Voilà, a statement on the immensity of Canada's oil potential that was meant to be uncomplicated and understandable but could hardly fail to be misunderstood in its final 'simple' form, which undermined both industry's and government's credibility. Poor linkage between the technical and policy levels is frequently the reason that numbers are separated from the explanations that describe their meaning.

The Department of Energy, Mines and Resources did not make its own quantitative resource estimates for the nation as a whole until 1972. In that year, estimates were made for oil and gas and also for the major metals mined in Canada. For the metals, a resource classification scheme was developed for the purpose (an adaptation from a scheme developed in the U.S. Geological Survey) and used for each individual commodity (figure 1). Only category 1A was called 'reserves', whereas the more general term 'resources' was defined to cover all categories.

While the scheme succeeded in separating apples from oranges and has contributed to the avoidance of meaningless summation of all the different categories, the results attracted little attention. The main reasons for this may have been:

i complexity of classification;
ii complexity of descriptive terminology;
iii unclear connection with supply.

At least to scientists, the provision of estimates in the form of such a scheme might have appeared to provide the answer. But what was the question? There could be many, such as: what are the possibilities for new discoveries? what might be the effects of R & D on exploitation methods? what supply flows could realistically be tapped from all this?

Quite often, the main interest is actually directed at supply possibilities, even though the questions may be construed in terms of resources. This is clear from the many attempts made at an easy leap from resources to supply. The most

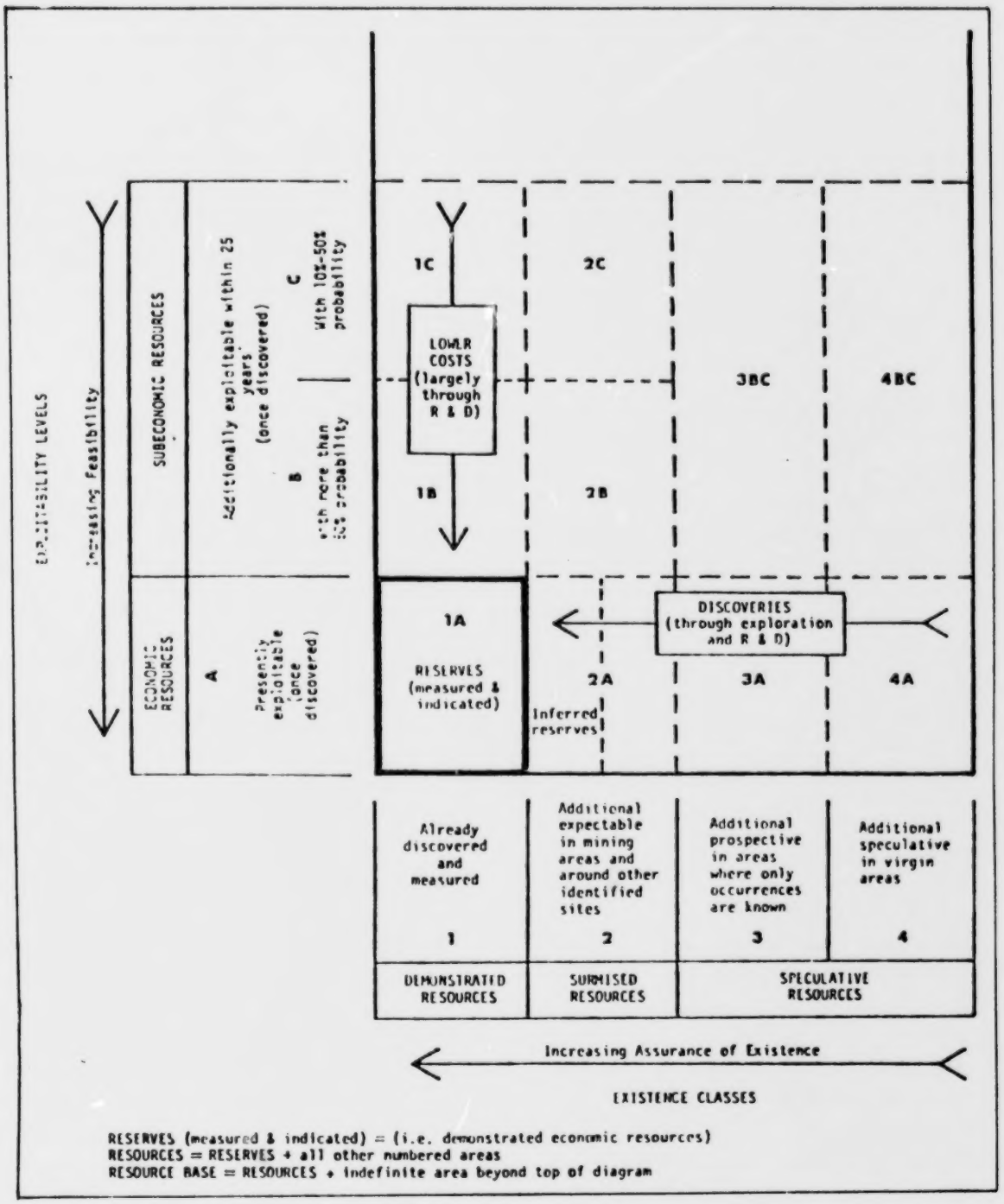

Figure 1. Classification scheme for mineral resources (metals, industrial minerals and coal) of the Department of Energy, Mines and Resources, Government of Canada.

simplistic, and probably most common, is as shown in figure 2 (from reference 2, p. 1001), where the existence of minerals is equated with their availability at any convenient rate and time.

A more critical look at a resource classification scheme shows that it leaves several important questions unanswered about possible supply flows: do the numbers represent resources in situ, or material recoverable in raw form, or material in the form of marketable products? How much is associated with producing facilities? How much is producible in the next few years? decades? Such considerations would expand a resource assessment into a supply assessment (figure 3; from reference 2, p. 1003)

A supply assessment tends to focus attention especially on the resources that will feed supply in the coming 20 years or so. In that context, it is of less interest to provide resource estimates frozen in time than to portray the dynamics of the foreseeable supply flow: the rate of withdrawals from the reserves category through mine production, and the rate at which reserves are being replenished with the aid of technological improvements and new discoveries (figure 4).

In portrayals of the dynamics of national supply, the much-abused concept of the 'life index' of reserves should have no place. Although it is valid when applied to an individual mine, in the aggregate it is a meaningless statistical average that can be highly deceptive to the general public - and to the policy analyst. Figure 5 shows the 'life index' in two of its incarnations, 5a and 5b; both incorrectly imply that current reserves in our mines will last a certain number of years, up to the year of collective and simultaneous exhaustion. The policy implication that production could continue to that point without any action to create new reserves is false. Only the scenario of 5c approaches realism. Without any additions to reserves or production capability, 5c shows the approximate exhaustion pattern of our current nation-wide reserves of a commodity. The policy implication is that, to keep up, we cannot afford to stop running. Within a very few years, we would no longer be able to meet domestic and export requirements if reserves were not replenished and production capability maintained.

Figure 6 shows schematically how such a 'supply monitoring curve' is derived. The horizontal bars in the upper part of the figure represent the years it would take to mine out the reserves of a metal at each of the mines A to H, at annual production rates estimated for each year. For simplicity, annual production rates are shown as multiples of some tonnage figure.

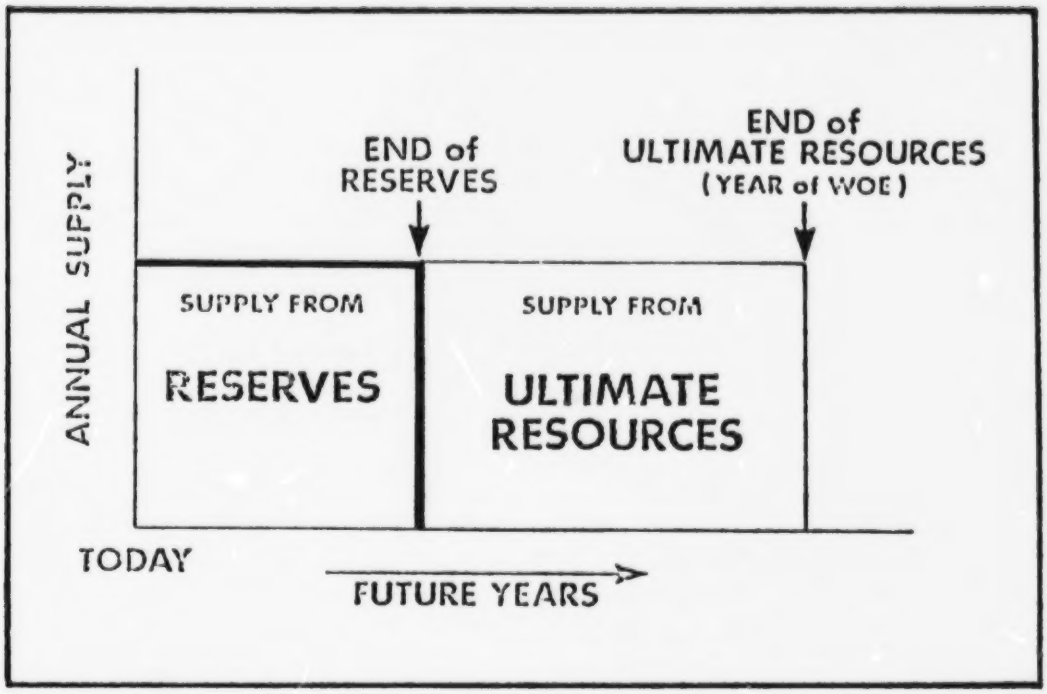

Figure 2. A common public misconception.

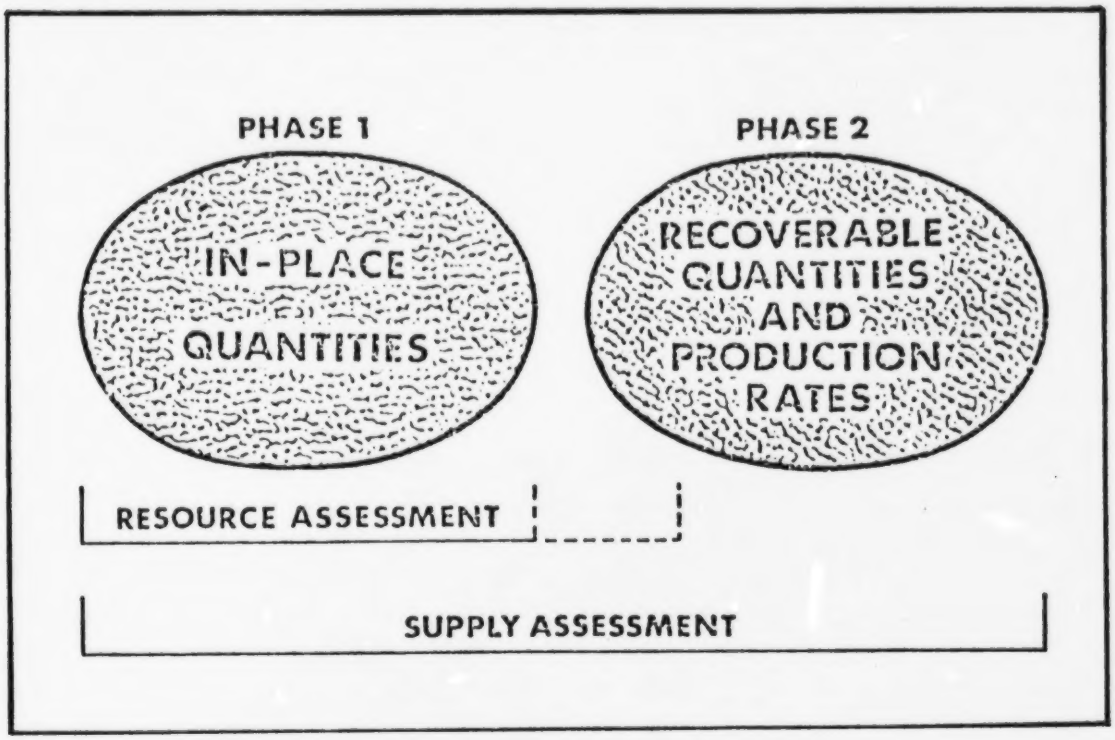

Figure 3. From resources to supply.

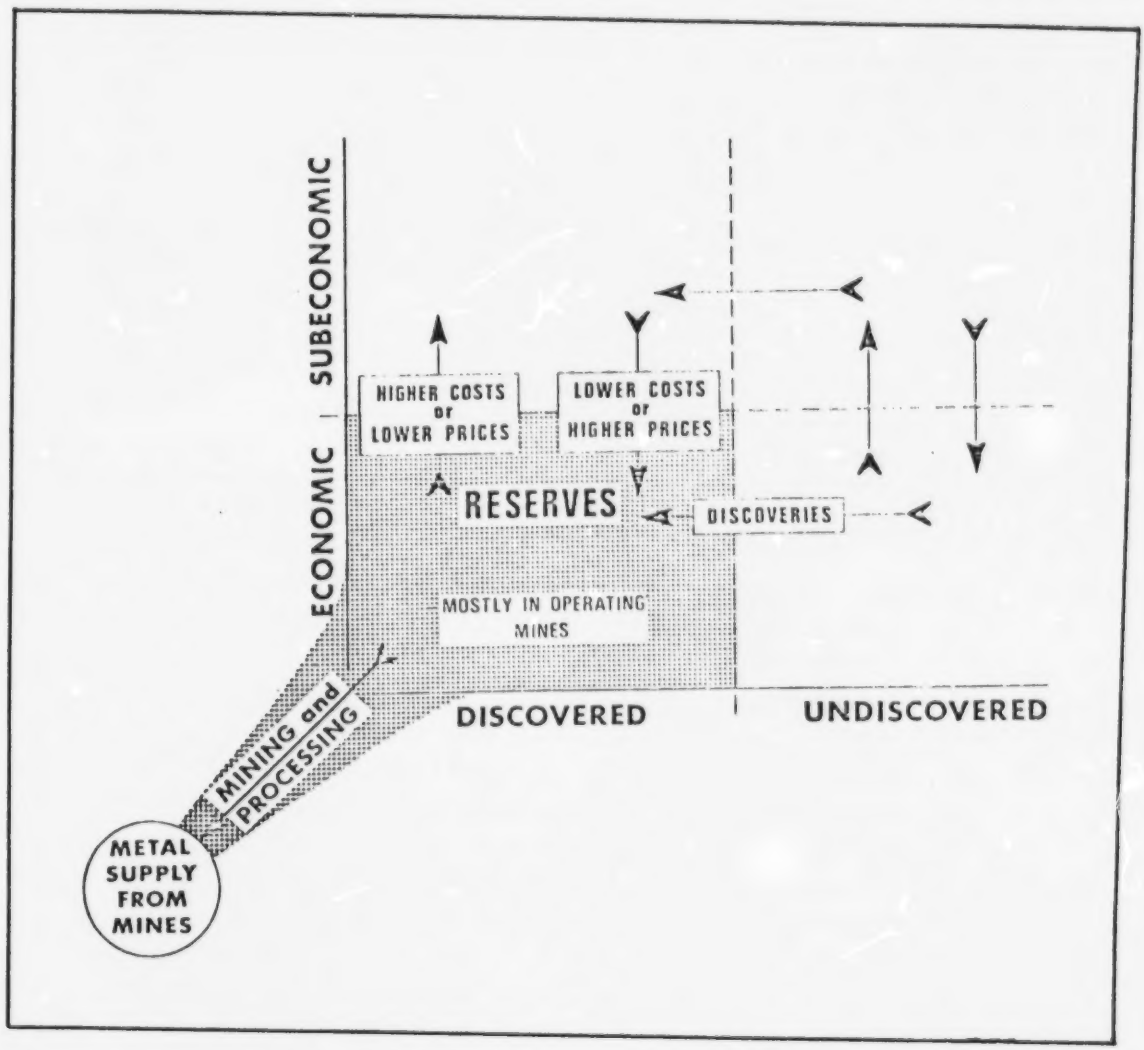

Figure 4. The flow of resources over time.

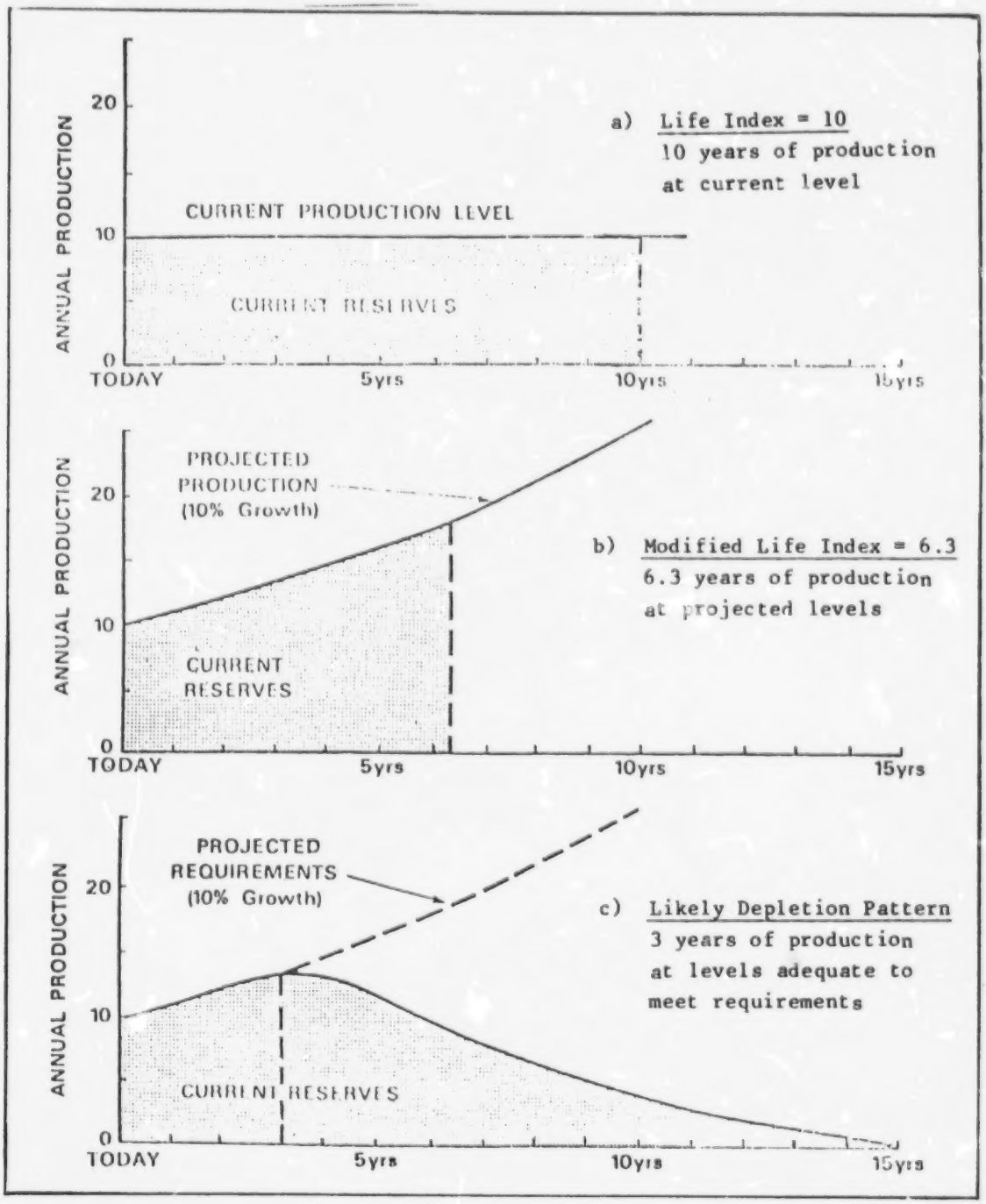

Figure 5. The 'life index' of reserves.

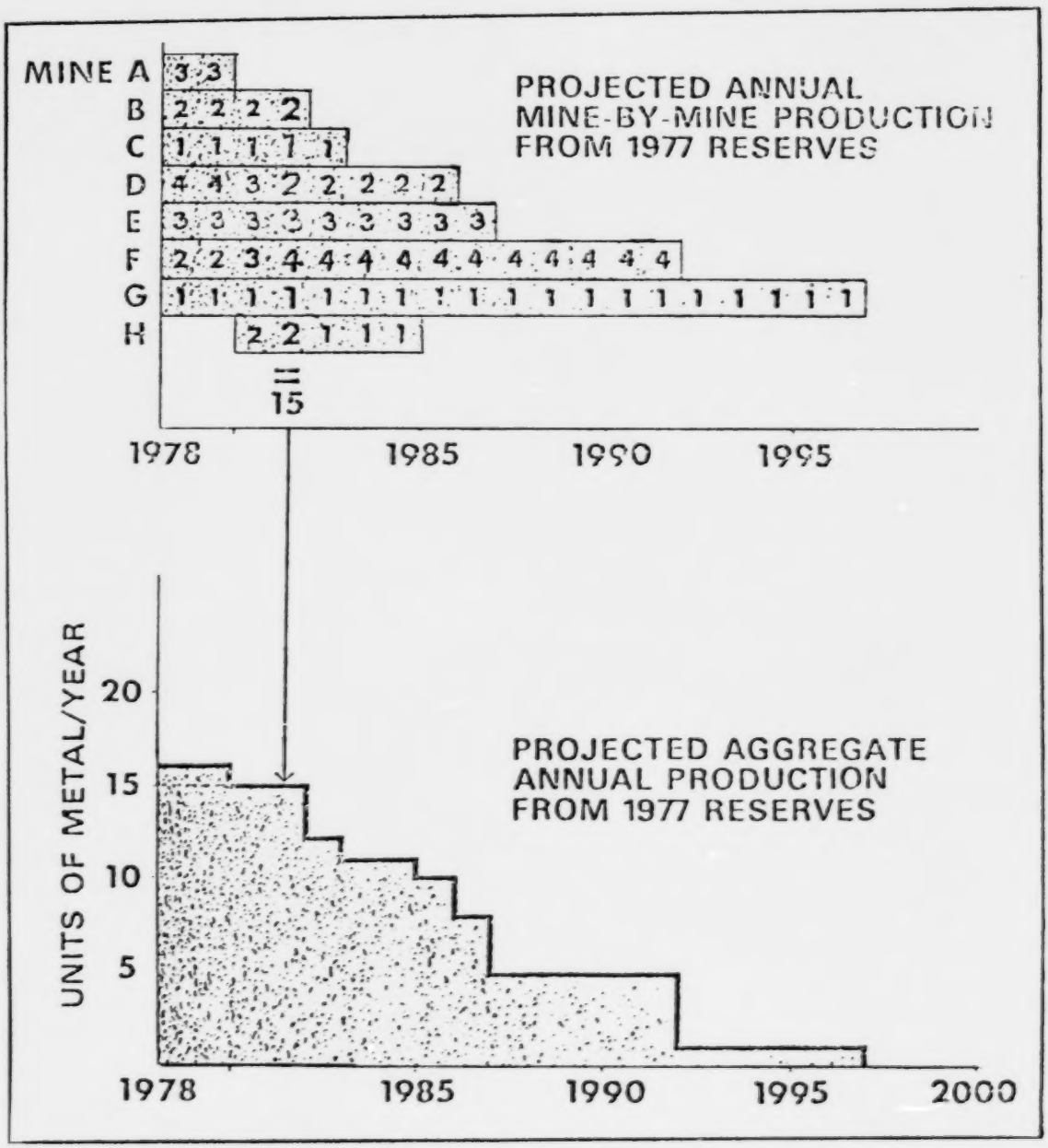

Figure 6. Schematic derivation of a supply monitoring curve.

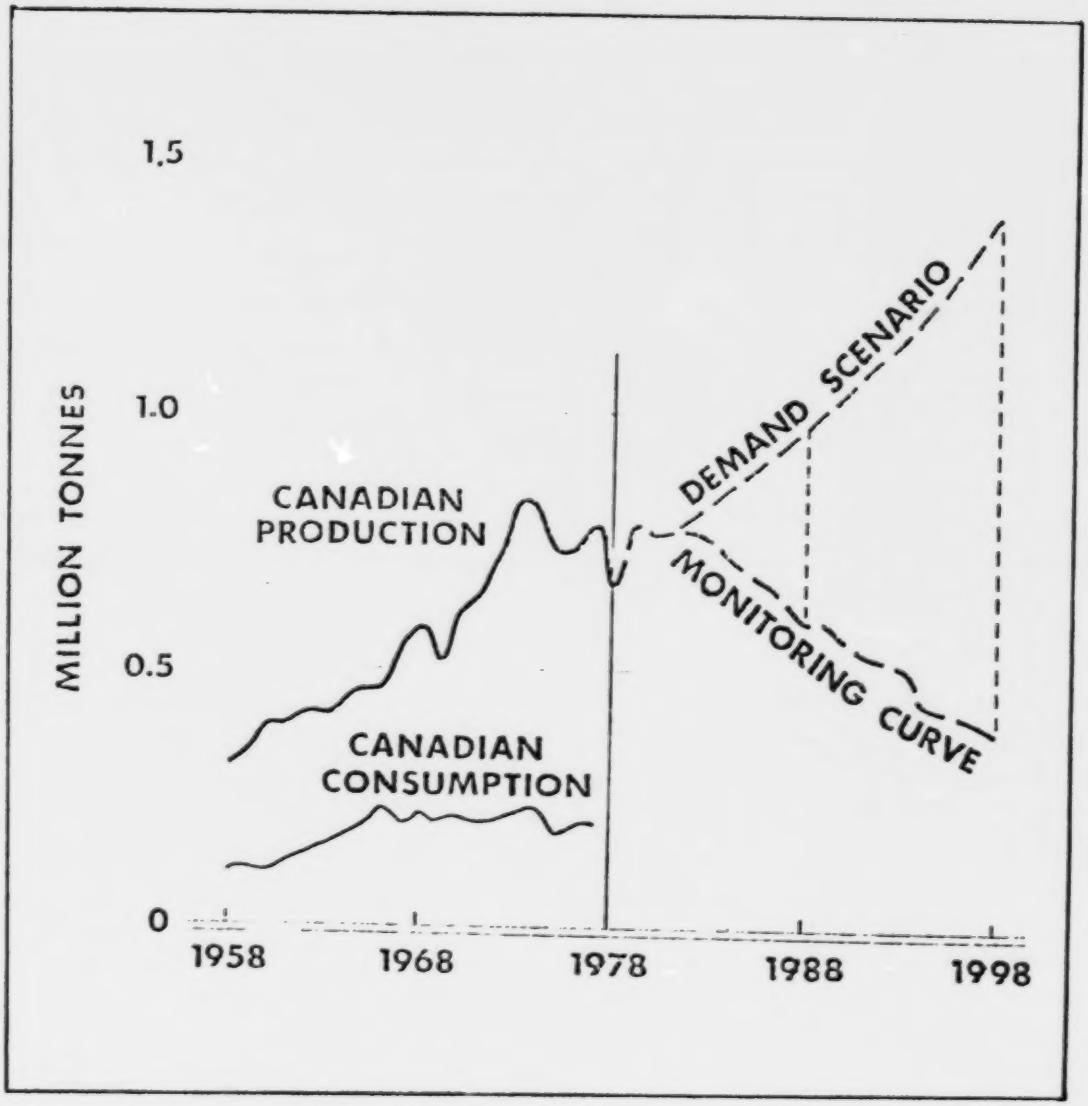

Figure 7. Copper (recoverable).

In an historical setting, the monitoring curve for copper constructed in 1978 looked as shown in figure 7. It can be seen that by 1988 about one-third of the total supply would have to come from new additions to 1978 reserves; by 1998, two-thirds would have to come from new reserves.

The same type of portrayal can be applied to resource categories other than reserves. Future supply from inferred extensions to current ore reserves can be shown separately. So can future supply from promising, but as yet undeveloped, deposits (figure 8; from reference 2, p. 1004).

Such portrayals are now provided annually for the use of policy analysts, along with an account of exploration activities, of discoveries, and of development activities.

The data collection is coordinated with the provinces. Agreement was reached some years ago on the questions that needed to be asked to obtain an adequate picture of the physical flow of materials: what is in the ground around mining operations, how much will be extractable, and how much is lost in concentrating, smelting, and refining. Industry has been cooperative in providing such data each year.

The format of figure 8, which combines pertinent resources information with the associated production capability, bypasses the complexities of resource classification and terminology which scientists cannot avoid but policy analysts should. It would be impossible to derive statements like '923 years' supply of oil' from information displayed as in figure 8.

This format surely helps in the most crucial area of communication problems between scientists and policy analysts, namely the area of interpretation of data. It is not so much in the selection and manipulation of data that the policy analyst needs the scientist's aid, but in assessing the meaning of the data.

At least in the field of resource and supply assessment, not enough attention has been paid to asking the right questions. Yet, this is the key to making headway not only in science but also in policy matters. Policy analysts and scientists need to put their heads together to formulate the exact nature and purpose of policy-related questions about mineral resources and supply. Judging from past experience, coordination at this initial stage is essential.

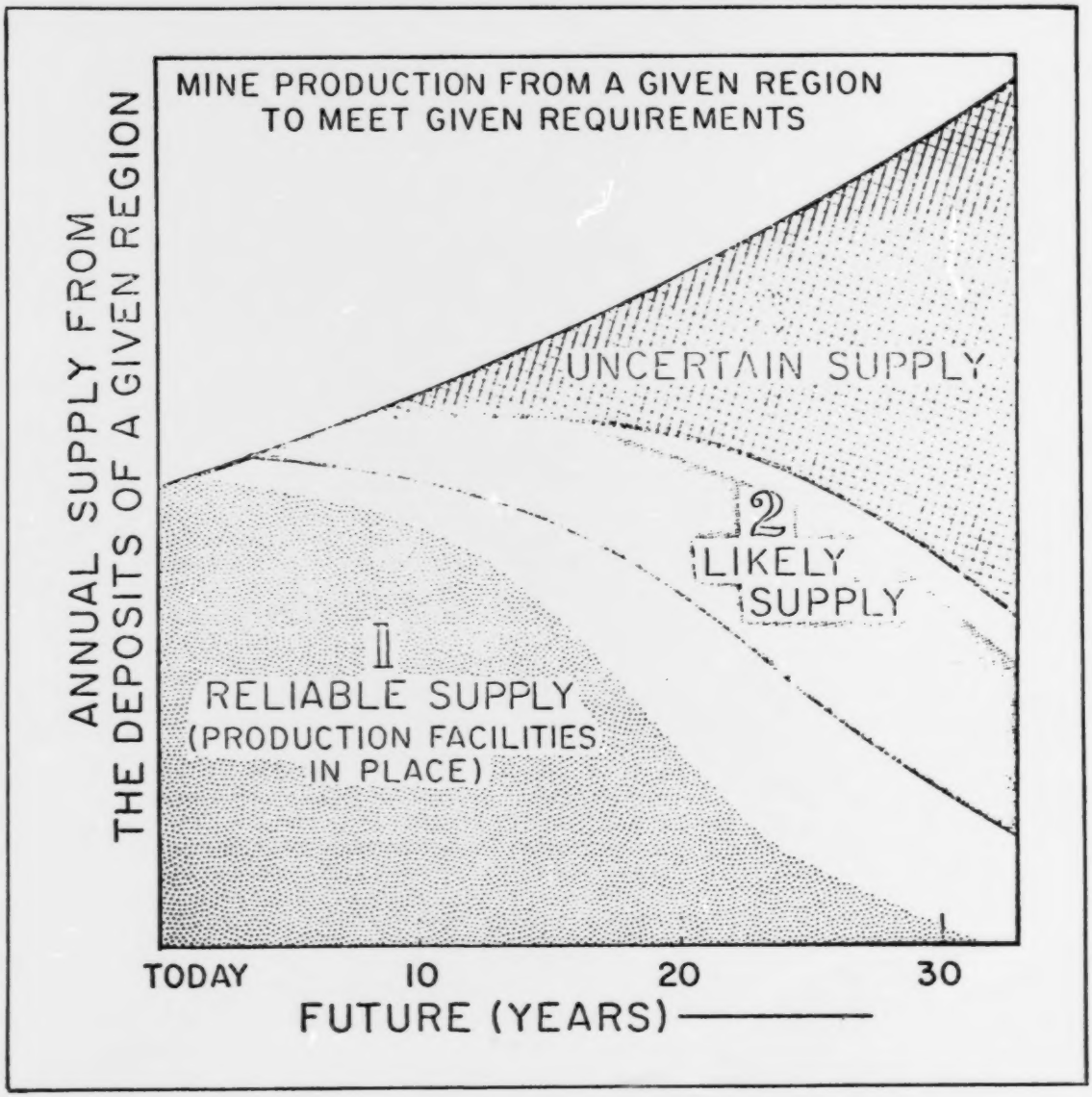

Figure 8. Supply of a mineral commodity.

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APPENDIX I

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APPENDIX II

PROGRAM

Tuesday June 22

7:00 p.m.	Introduction to the seminar Andrew J. Freyman
7:45 p.m.	'Providing Policy Advice to Government: The Role of Scientific and Technical Knowledge' George A. Jewett

Wednesday June 23

8:30 a.m.	'Role of Scientific and Technical Knowledge in Mineral Policy Formulation: An Industry Perspective' Herbert D. Drechsler
10:00 a.m.	'The Widening Gap: The Loss of Technical Input in Policy Advice' Philip G. Halkett
11:15 a.m.	'Providing Policy Advice to Central Planning Agencies: A Federal Viewpoint' David E. Bond
2:00 p.m.	'Regional Mineral Resource Assessment' D.C. Findlay
3:30 p.m.	'Government Involvement in Mineral Science and Technology' W.G. Jeffery
7:00 p.m.	'Mineral Market Research and Strategies' L. George Bonar

Thursday June 24

8:30 a.m.	'Mine Development Agreements Between Government and the Private Sector' Dallas W. Davis
10:00 a.m.	'Monitoring and Assessing the Mineral Supply Process' Jan Zwartendyk
11:15 a.m.	Workshop Session
1:30 p.m.	Workshop Reports and Closing Discussion

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